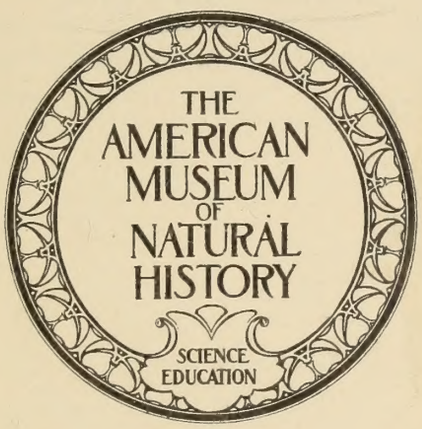
ANTHROPOLOGICAL PAPERS

OF

THE AMERICAN MUSEUM OF NATURAL HISTORY

VOL. XII



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Editor

CLARK WISSLER

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ANTHROPOLOGICAL PAPERS

OF THE

American Museum of Natural History.

Vol. XII, Part 1.

STRING-FIGURES FROM THE PATOMANA INDIANS OF BRITISH GUIANA

BY

FRANK E. LUTZ.

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VOLUME XII, PART I.

STRING-FIGURES FROM THE PATOMANA INDIANS OF BRITISH GUIANA.

BY FRANK E. LUTZ.

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Introduction.

While on a zoölogical expedition in British Guiana, I camped for about a month in the vicinity of Kaieteur Falls. Our Indian helpers came from near the Brazilian border still further up the Potaro River. Among them was a bright little fellow about twelve years old who was with me nearly the whole time and who taught me the figures described here. As usual, he would not tell his real name but, as "Crickety" described his happy disposition and sounded something like the one he gave, it was the name that was used.

These Indians called themselves Patomana. The name is doubtless synonymous with Paramona, a sub-tribe of the Ackawoi, of Carib stock. They are almost entirely untouched by civilization although most of them have at least seen strangers and a few of them wear white man's clothes.[1] Crickety was apparently a champion string-figure artist, as ten or a dozen of the Indians with whom we came in contact tried to show me figures he had not, but failed. The notes given here include all that either rivalry or promises of gifts could extract, so that they are probably rather complete for that section.[2]

The chief point of difference from the figures made by other primitive peoples, as a whole, seems to lie in the common use these Indians make of the shift of loops from the fingers of one hand to the corresponding fingers of the other hand. It is interesting that, with the exception of "tricks" none of these games seem to be duplicated in other parts of the world. To be sure, the end results of two of them are the same as the end results of games by other peoples, but the method of getting these results is different (Figs. 4 and 10).

Position 1, which is the basis of so many string-figures, consists in having the string back of the thumb and little finger but in front of the other fingers.[3] All the figures are made with a string (these Indians made their strings of

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[1] See "The American Museum Journal," Vol. 11, p. 283.

[2] As noted in Miss Haddon's recent book on "Cat's Cradles" there is a dearth of data for South American natives. Dr. W. E. Roth collected twenty-four string-figures from the Arawak and Warrau on the Pomeroon and Moruca Rivers (Revue des Études Ethnographiques et Sociologiques, 1908, p. 193), but did not give directions for making them. In all his twenty-four figures we find but one described by Dr. Lutz: viz. the fish trap, the name also being in common. The remaining figures seem totally different and on the whole much more complicated than those described in this paper or for that matter in any other publication. As those here described are from the Brazilian frontier they represent one of the wild interior tribes in contrast to those of the coast among whom Dr. Roth collected.

The bibliography of string games may be found in Mrs. C. F. Jayne's book on "String Figures" and Miss Kathleen Haddon's "Cat's Cradles from many Lands." To these have been added a few titles in a book review by Hertermann, Anthropos, Vol. 6, p. 1053.— Ed.

[3] See Miss Haddon's "Cat's Cradles from many Lands," p. 3.

fiber from the inside of bark) tied to form a circle. Unless otherwise stated, Position 1, means that the string is placed in this manner on each hand.

Opening A consists in placing the string in Position 1 and taking up the palmar string of the left hand from the proximal side on the dorsum of the right index finger. Then reach between the strings of the right index loop thus formed and take up the palmar string of the right hand from the proximal side on the dorsum of the left index finger.

Parrot.

Place a short loop between the index and middle fingers of the left hand. Bring it to the palmar side, passing one string between the thumb and index finger and one string between the middle and ring fingers. Rotate it clockwise, looking at the palm, through 180° and return to the dorsum of the index and middle fingers combined by passing the radial string between the thumb and index fingers and the ulnar string between the middle and ring fingers. Tighten the strings by pulling the long loop.

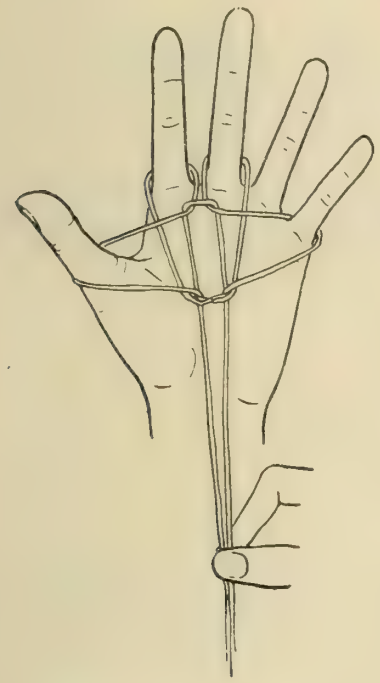

Fig. 1. The Parrot.

There will be two strings between the index and middle fingers. Reaching in from the distal side between the other strings, pull the radial string of the middle finger loop out and place it on the little finger. Likewise, place the ulnar string of the index finger loop on the thumb. Pull the loop running back of both the index and the middle fingers over these fingers and release it on the palmar side. Now, pull the long loop and alternately close in and separate the thumb and little fingers and the parrot will fly (Fig. 1). A fairly short hold should be taken on the long loop to make a "kawack" or green parrot, for it has a short tail. This is an interesting figure on account of the movements used when it is finished.

Toad.

Position 1 on the left hand. Pull the palmar string into a long loop, making the former long loop a palmar string proximal to it. From the distal side pull out the new palmar string into a long loop. Reaching into this long loop from the distal side pull out the strings passing outside of the thumb and little finger respectively into two long loops.

a Pass from front to back the radial string of the radial loop between the thumb and index fingers, the ulnar string of the ulnar loop between the middle and ring fingers, and the two remaining strings between the index and middle fingers, allowing the loops to hang loose behind.

There will be a loose palmar string and one close to the hand. Reaching proximal of this loose one, pull into long loops the strings which pass between

the index and middle fingers. This will make an apparently hopeless tangle. Repeat *a*.

b Pull the loops that were on the index and middle fingers before *a* was repeated through the new loops and as far out as they will go, leaving the new ones on. This is best done by using the dorsum of the index and middle fingers of the right hand.

Now release the loops on the index and middle fingers of the left. Separate the hands and a rectangular figure will result which may need a little adjustment at its left corner. Repeat *a*.

Reaching under the string which runs from between the thumb and index fingers to between the ring and little fingers, pull the strings which pass between the index and middle fingers being sure to take hold of them just after they have curled around a cross string and started diagonally down the palm. Repeat *a* and *b*. With a little care in separating the hands the figure will result (Fig. 2).

The native name for this figure is "crapo."

Bush.

Position 1. Twist the palmar strings so that the one from between the thumb and index finger crosses distally the one from between the ring and little fingers. Pass the distal string across the palmar side of the little finger, then around it, between it and the ring finger, across the palm between the index finger and the thumb, making a loop around the latter. There will be one string passing directly across the palm and the proximal of it will be a pair of crossed strings. Put the index and middle finger of the right hand between the crossed strings of the left hand from the proximal side so that the crossing is between the fingers and separates the hands. Do the same with the left hand and the strings on the right taking care that the two strings from between the index and middle fingers of the right hand are between the index and middle fingers of the left before they take up the crossed strings. There will be two loops on each little finger and each thumb. Of these two loops, one of them has a string running to the middle of the mesh. Pull this in each case from the dorsal side, proximally of the other, then pass it over the finger or thumb and release, leaving the other string on. Separate the hands.

Slip the index and middle fingers of the right hand into the loops of the corresponding fingers of the left on the dorsal side and remove these loops to the right hand. Slip the index and middle fingers of the left hand into the loops originally on the corresponding fingers of the right on the dorsal side

and remove these loops to the left hand, bringing over (dorsally) the loops which were originally on the left. Separate the hands quickly with the fingers spread so that the strings "catch" (Fig. 3).

The loops on the one hand represent the roots and those of the other the

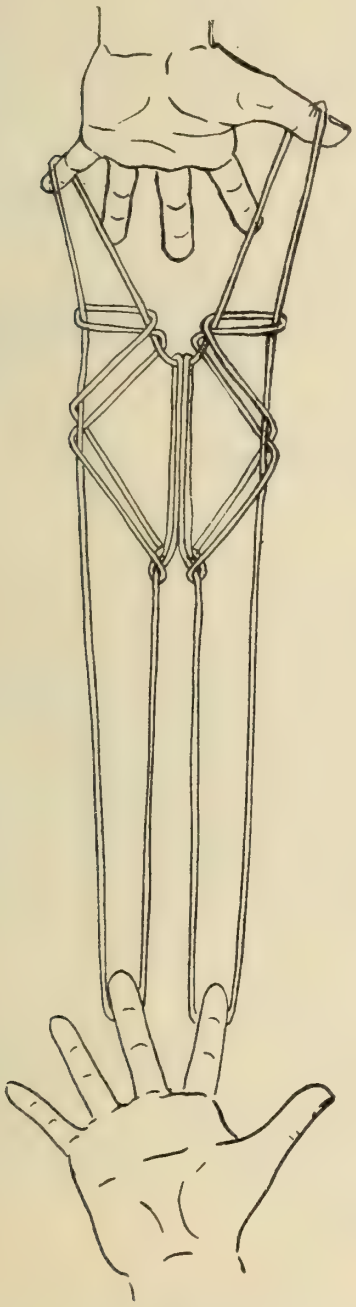

Fig. 2.

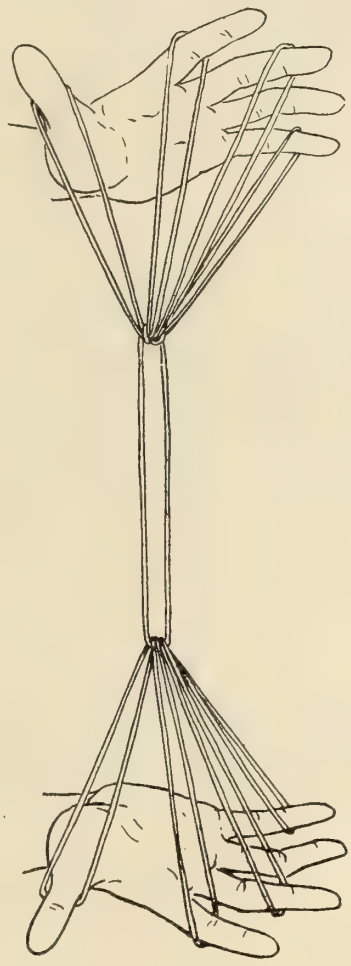

Fig. 3.

Fig. 2. The Toad.
Fig. 3. The Bush.

branches of a "bush" which is the general name among the Indians who have come in contact with white men for any sort of a tree. I used an extra long string in learning the figure and Crickety laughingly pointed to a liana.

Mountain.

Opening A. Release the thumbs. Take the loops from each little finger and place them on the distal end of the corresponding index finger upside down, the turn being anti-clockwise on the left hand as you look at the palm and clockwise on the right hand. "Basket work" the thumbs, i. e., place each distal of the proximal string between the thumb and index finger, proximal of the proximal string between the index and middle fingers, distal of the distal string between the thumb and index finger and proximal of the distal string between the index and middle finger. Return to position.

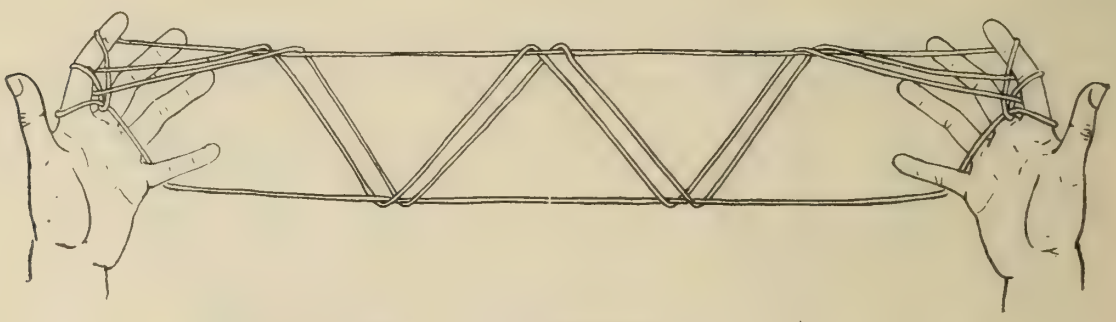

Fig. 4. The Mountain.

Basket work the little fingers by placing each distal of the string running from the index directly to the center of the mesh and proximal to the one running directly between the index fingers. Return to position.

Putting each index finger distal of the palmar strings twist on their ends the string running on the palmar side of the little finger by putting the index finger between this string and the little finger from the distal side and taking the string up on the back of the finger. Return to position. Release the thumbs and pull taunt, turning the palms from you (Fig. 4). The end result is much like "Little Fishes" from Murray Island but achieved in a different manner and much more appropriately named.[1]

Baboon's Mouth.

Place both hands in the string so that it passes back of each wrist. Grasping the strings near the middle with the right hand pass, from front to back, the radial string between the thumb and index finger of the left hand and the ulnar one between the middle and ring finger of the same hand. Return them to the front by passing them between the index and middle

[1] Miss Haddon, "Cat's Cradles from many Lands," 12.

fingers. Pass the index finger one of the pair between the thumb and index, making a half loop on the thumb. Pass the middle finger one of the pair between the ring and little finger, making a half loop on it.

Take up on the dorsum of the index and middle fingers of the right hand the strings passing in front of the same fingers of the left. Separate the hands. Slip the left wrist loop over the hand and release. Transfer the

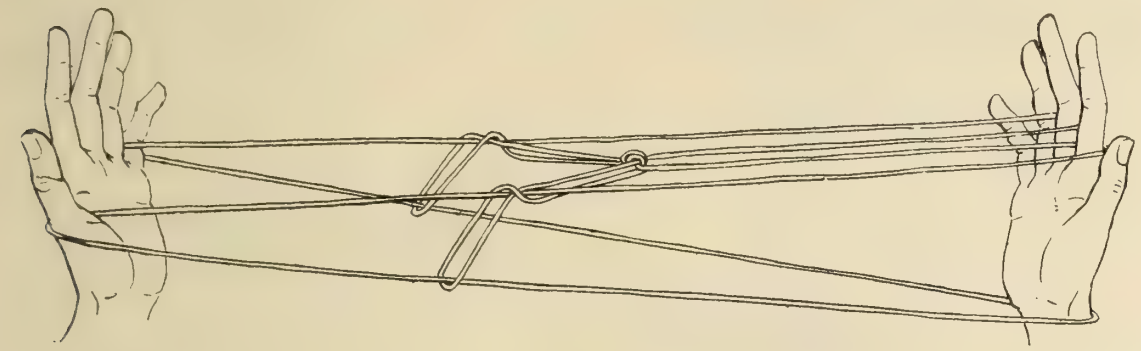

Fig. 5. The Baboon's Mouth.

index and middle finger loops of the right hand to the same fingers of the left. Pull the loops originally on the left index and middle fingers over these and the ends of the fingers and release them. Transfer the loops back to their original position on the right hand. Separate the hands (Fig. 5).

"Baboon" is the name given in British Guiana to the howling monkey. The figure resembles much more an alligator's mouth and as "cayamans" are fairly common, I am surprised at the name.

Monatà.

The same operation as "Baboon's Mouth" except that one starts with only the left hand in the loop. I am not certain as to the translation of monatà but think it means a door (Fig. 6).

Bird Snare.

The same operation as "Monatà" except that a second loop is put on the left wrist by passing the ulnar string around the wrist once. A little care is necessary to get a good loop in the snare (Fig. 7). This is a fair representation of the snare Crickety made for actual use, the details of which are shown in the accompanying diagrams, Fig. 8.

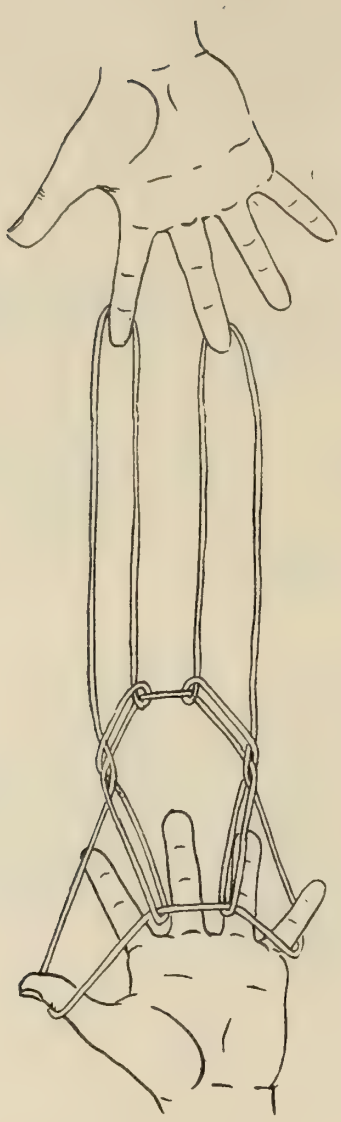

Fig. 6.

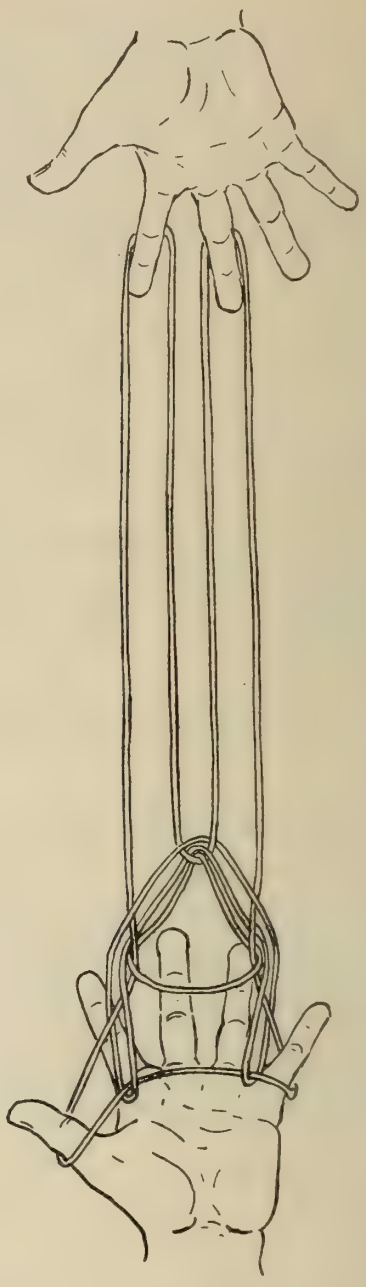

Fig. 7.

Fig. 6. Monatâ.
Fig. 7. The Bird Snare.

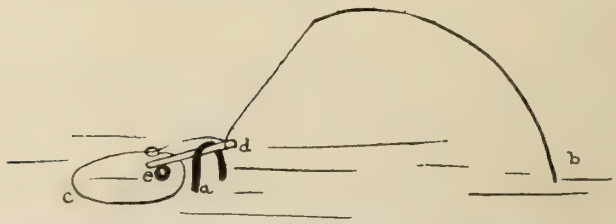

Fig. 8. Sketch of a Snare used for taking Birds. *a* A stout twig with both ends driven well into the ground; *b* a pliable stick or sapling; *c* a slip noose; *d* a smooth stout stick; *e* a pebble. The bait is either fastened to *d* near *e* or scattered about inside the loop. In the latter case, they depend on the movements of the animal to knock *d* off of the pebbles and thus spring the trap.

Fish Trap.

Put the left hand in the string so that there is a loop back of the wrist. Put on a second (complete) one by passing the ulnar string around the wrist. Pass the strings of the long loop from front to back between the index and middle fingers and then from back to front between the middle and ring fingers. Reaching under (from the radial side) the strings, which run from the wrist to the fingers, pull the long loop through. Pass the radial string of the long loop between the index finger and the thumb, making a half loop

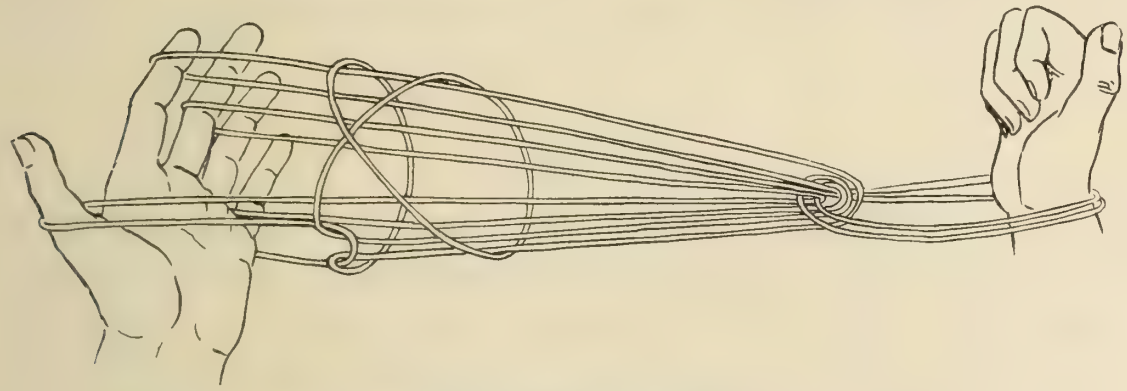

Fig. 9. The Fish Trap.

on the thumb; and the ulnar string of the long loop between the ring and little fingers, making a half loop on the latter. Take up on the dorsum of the index and middle fingers of the right the last mentioned strings respectively and separate the hands. Run the whole right hand into the loop about the left middle finger, doing so on the dorsum of the finger and from the distal side of the loop. In this way remove the loop to the right wrist. Separate the hands. Put the loops of the index and middle fingers of the right hand on the same fingers of the left. Slip the wrist loops of the left over the left hand and release them. Separate the hands (Fig. 9).

The native term for this figure is "mashowo" or fish trap.

River.

Put each hand in the string, having it run back of the wrists. Bring the left ulnar string to the radial side and proximal of the radial string, then distal of it and place it on the little finger without twisting it. The strings to the right hand will, however, be twisted near the middle. Run the right little finger from the radial side under the upright string, which runs between the left ring and little finger, taking this string up on the dorsum of

the finger and separate the hands. Place each wrist loop on the corresponding index finger without twisting (Fig. 10).

Passing each thumb on the distal side of the index loops, take up on its dorsum from the proximal side, the strings between the ring and little fingers. Return the thumbs to position and place on their distal ends that part of the index loop which is between the index fingers and the thumb.

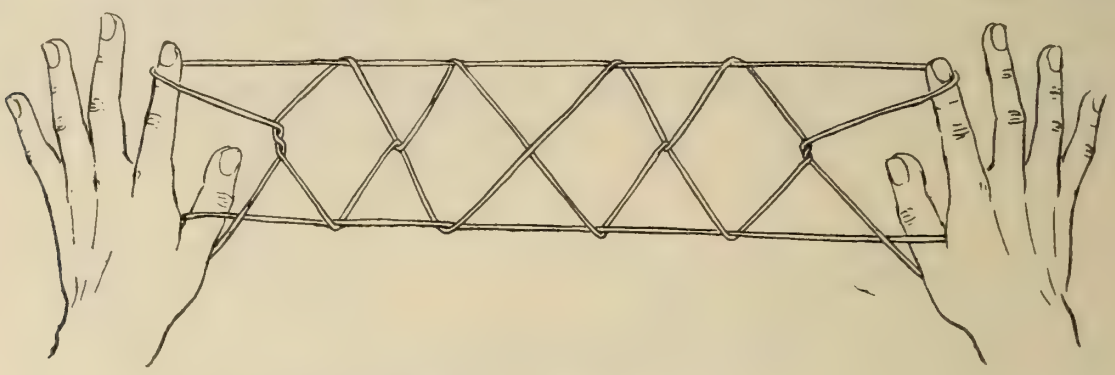

Fig. 10. The River.

Release the first loop put on the thumbs by pulling it over the second and the end of the thumb. There will be a triangle formed between each thumb and index finger. Place each index finger in its triangle from the distal side and continue the twisting of the hands (toward the body, then down, then out) at the same time releasing the little fingers. If the thumbs and index fingers are not kept well apart the figure will be narrow. I suggested to the Indians that this was the dry season. They laughingly agreed but I do not think they had thought of it before as they immediately made wet and dry season rivers for each other. This figure is exactly like "Osage diamonds" of Mrs. Jayne but it is arrived at in a very different way and the interpretation is different.[1] Crickety called it Pis, or river.

Star.

Position 1. The next step is a variation of opening A in that the index fingers take up the palmar strings from the distal side instead of from the

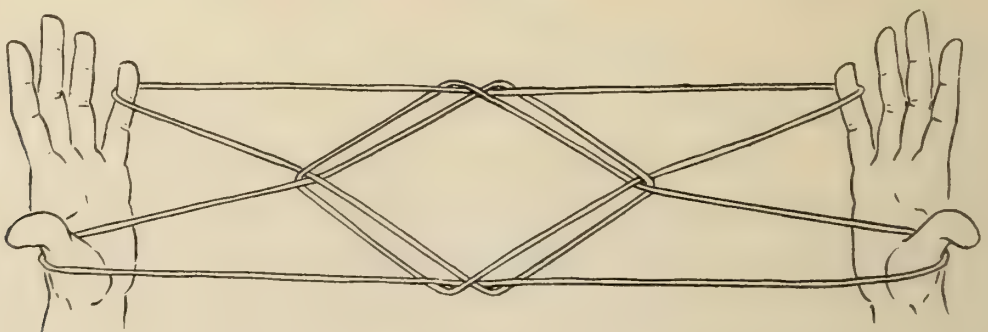

Fig. 11. A Star.

[1] String Figures, 24.

proximal. Reaching between the strings of the index loops from the distal side, pull the thumb loops off the thumbs, between the strings of the index loops and replace them on the thumbs. Treat the index loops the same way by reaching between the strings of the thumb loops; also the little finger loops by reaching between the strings of the index loops. Release the index loops and separate the hands (Fig. 11).

Fly.

Have one loop over each thumb, the strings running directly between the thumbs. Twist the left hand so that the two strings run along the dorsal surface and pass to the right from the ulnar side. With the right little

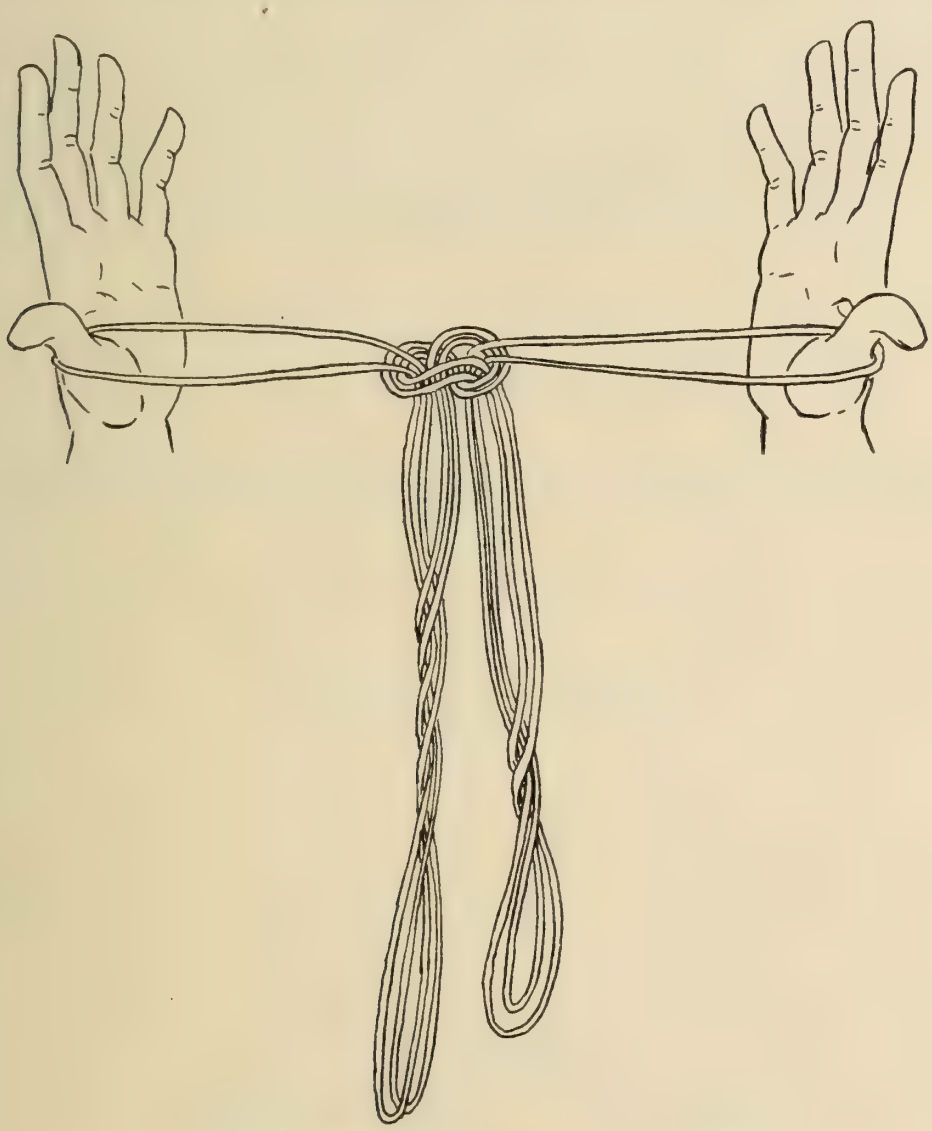

Fig. 12. A Fly.

finger reach behind the left hand on the radial side and take up both strings on the back of the finger. Return to position. With the little finger of

the left hand reach over (distal of) the strings running to the right little finger and take up the strings running to the right thumb on the dorsum of the finger. Return to position.

Raise the left wrist loop free of the hand and separating the hands, slowly draw it into a knot about midway between the hands. This is the fly (Toolik). The wings are now dropped by releasing the little fingers (Fig. 12). Try to catch the fly by slapping the hands together but when you separate them (quickly and as far as possible), the fly is gone.

This may be called a "trick" rather than a string figure. Crickety also knew the "hanging" trick although he used his feet instead of his head as is usually done. However, the trick he seemed to enjoy most was "warum" or "snake." It is the widely distributed "mouse." His explanation was that the fingers of the hand (held upright) are trees and the released string is a snake crawling in and out among them. While I was there, an Indian who had been down to the settlements taught Crickety the well-known trick of putting a stick into the loop of an open string, winding the string on the stick and then after blowing on the whole business the string is unwound with the stick free from the loop. I think he undoubtedly got it from the negroes.

ANTHROPOLOGICAL PAPERS

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American Museum of Natural History.

Vol. XII, Part II.

PREHISTORIC BRONZE IN SOUTH AMERICA.

BY

CHARLES W. MEAD.

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PREHISTORIC BRONZE IN SOUTH AMERICA.

By Charles W. Mead.

CONTENTS.

ILLUSTRATIONS.

Text Figures.

INTRODUCTION.

The principal object of this paper is to put on record the results of one hundred and sixty analyses of prehistoric copper and bronze objects from Peru and Bolivia. These analyses were made for the American Museum of Natural History by Mr. W. A. Wissler. Also six specimens analyzed for the Museum by Doctors Morris Loeb and S. R. Morey, and five specimens analyzed by Professor S. P. Sharples for the Peabody Museum, Harvard University, for which I am indebted to the kindness of Professor F. W. Putnam.

The figures show most of the forms of objects from which samples of metal have been taken for these analyses.

In the following tables the amount of copper and tin is given. It was not considered important to determine the exact amount of the other metals, but their presence or absence is noted. For convenience, chemical symbols have been used.[1]

Mr. Wissler reports on his analyses, as follows: —

The table consists of analyses made at the American Museum of Natural History of prehistoric bronze and copper specimens from South America, to determine whether the addition of tin was intentionally and scientifically made.

Owing to the small amount of drillings taken for the analyses, in some cases only .07 gram, the results should be taken as a close approximation of the true composition.

Tin was determined as stannic oxide, by the method of Busse. In all cases where the total precipitate weighed less than 15 mg. it was weighed as such. If there was more than this amount the precipitate was fused with caustic potash and the tin determined electrolytically. Copper was determined by iodometry, excepting that in all cases where the total amount was less than .15 gm. it was determined electrolytically.

Qualitative tests were made by the Johnson-Marsh test for arsenic and antimony, dimethyl glyoxime for nickel, and the ordinary routine methods for the other metals. Tin was detected by the presence of the oxide after solution in nitric acid, and was found to appear plainly and certainly when present to the amount of .00001 gram. The table records all tests made, whether with positive or negative results.

In some cases, as for example in catalogue numbers 9195 and 9188, the specimens were so corroded that the initial weight of the sample was discarded, a complete analysis made, and the total weight of the metals found taken as the true weight.

Numbers 3114 and 5166 are distinctly estimates, probably correct within one percent of the true analysis. In numbers 2486, 760, 4599, 7791, 9193, 9205, 9194, 9198, 2821a, 2644, 9199, 2792b, 2800, 2639, 9191, 9190, 2791a, 2804, 2821b, 9208, 857, 858, 860, 6584, 9187, 4265, 2791b, 2821c, 1819, 1955, 5192d, 9189, 1961, 2094, 1965,

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[1] Cu, copper; Sn, tin; Pb. lead; Ag, silver; As, arsenic; Sb, antimony; Ni, nickel; Zn, zinc; S, sulphur; Au, gold; Fe, iron.

1807, 1998, 2068, 9206, 2643, 9210, 1834, 1806 copper was determined by difference after the absence of other metals had been established.

In several cases the absence of lead has been marked with a question mark, as at the time it was not considered necessary to test for it, but if present it would very probably have been noticed in the method of analysis used.

In a paper by Doctors Loeb and Morey, read at the December (1909) meeting of the American Chemical Society the six specimens analyzed by them for the Museum are thus described: —

It will be seen that these metals differ remarkably in composition, and indicate the possession of considerable metallurgical skill by the inhabitants of that region. The absence of the slightest traces of silver may be taken as a proof that the tin was derived from cassiterite, rather than native tin. The specimen, catalogue number 859 (this is the socketed spear point from Chan Chan on the northern coast), suggests its preparation from domekite, or some other copper arsenide, fairly free from sulphur. Owing to the small mass of samples, which were drilled or cut from the specimens, the density determinations, made with water in a pycnometer, are only approximate. In specimen, catalogue number 1949, a cast chisel with characteristic air-holes or "pipes," the porosity of the material undoubtedly occasioned a low result. Tin and copper were separated by potassium polysulphide, the former determined as stannic oxide and the latter electrolytically. Arsenic was separated from copper by Crookes' method, and sulphur was weighed as barium sulphate after oxidation with nitric acid in a sealed tube.[1]

Of these six objects five come from the Island of Titicaca, Bolivia. They all contain tin, the average being 6.59 percent. The spear point comes from Chan Chan on the northern coast and contains no tin.

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[1] Journal of the American Chemical Society, vol. XXXII, No. 5, May, 1910.

ANALYSES.

Table I. By W. A. Wissler.

Cat. No.	Locality.	Object.	Cu.	Sn.	Present.	Absent.
5151	Chepen	Agricultural impl.			Cu.....trace Fe.	Sn., Pb., Ag., As., Sb., Ni., Zn.
5152	"	"			Cu.....trace Fe.	Sn., Pb., Ag., As., Sb., Zn.
5153	"	"			Cu.....	Sn., Pb., Ag., Ni., Zn.
5154	"	"			Cu.....trace Sn.?	
5155	"	"			Cu.....	Sn., S.
5156	"	"			Cu.....	Sn.
5157	"	"			Cu.....trace Fe.	Sn., Pb., Ag. Sb., Ni., Zn.
5158	"	"			Cu.....trace Fe.	Sn., Pb., Ag., Ni., Zn.
5159	"	"			Cu.....	Sn., Ag., Pb., S.
5160	"	"			Cu.....	Sn., Ag., Pb., Fe., Zn.
5161	"	"			Cu.....	Sn.
5162	"	"			Cu.....	Sn.
5163	"	"			Cu.....trace Fe.	Sn., Pb., Ag., As., Sb., Ni., Zn.
5164	"	"			Cu.....	Sn., Zn.
5165	"	"			Cu.....trace Fe.	Sn., Ag., Pb., Sb., As., Ni., Zn.
5166	"	"			Cu.....	Sn., Ag., Pb., Sb., Fe., Zn.
5167	"	"			Cu.....trace Sn.?	Ag., Zn.
5168	"	"			Cu.....	Sn.
5170	"	"			Cu.....	Sn.
5171	"	"			Cu.....	Sn.
5172	"	"	99.62	.015	S (.265).....	
5196	"	Chisel			Cu.....	Sn.
5198	"	Chisel or Ax			Cu.....	Sn.
5184	"	Chisel	98.45	1.04	.....	Pb.?
5197*b*	"	Knife			Cu.....	Sn.
5197*a*	"	"			Cu.....trace Sb.	Sn.
5197*h*	"	"			Cu.....	Sn.

5197*l*	"	"	96.13	3.54	.....	Ag., Pb., S.
5195	"	"	92.00	7.98	.....	Pb.
5193	"	"	.....	.....	Cu.....	Sn.
5192*e*	"	"	.....	.....	Cu.....	Sn.
5197*k*	"	"	96.68	.....	.....	Sn., Pb.
5191	"	"	98.61	.....	.....	Sn., Pb.
5176	"	"	98.25	.....	trace Sn.....	Pb.
5148	"	Trowel.....	.....	.....	Cu.....	Sn.
5175	"	"	.....	.....	Cu.....	Sn.
5150	"	"	.....	.....	Cu.....	Sn.
5174	"	"	.....	.....	Cu.....	Sn.
5179	"	"	.....	.....	Cu.....	Sn.
5198	"	Sheet copper.....	.....	.....	Cu.....	Sn.
5191*c*	"	"	.....	.....	Cu.....	Sn.
5192*d*	"	"	.....	.....	Cu.....	Sn.
5169	"	Spear point	.....	.....	Cu.....	Sn.
5199	"	"	.....	.....	Cu.....trace Sn.?	Ag., Pb., S.
5194*k*	"	Cutting or digging impl.	98.60	.....	.....	Sn.
5192*e*	"	"	96.01	3.77	.....	
5218*d*	"	Fragment.....	.....	.....	Cu.....	Sn.
5200	"	Nugget.....	.....	.....	Cu.....trace Fe.	Sn.
5197*i*	"	Cutting implement.....	.....	.....	Cu.....	Sn., Pb., Zn.
5191*g*	"	"	.....	.....	Cu.....	Sn., Pb., Zn.
5194*a*	"	"	98.71	.....	.....	Sn.
816	Trujillo.....	Agricultural impl	.....	.....	Cu.....	Sn.
855	"	"	.....	.....	Cu.....	Sn.
856	"	"	.....	.....	Cu.....	Sn.
857	"	Spear point.....	.....	.....	Cu.....	Sn., Ag., Pb., S.
860	"	"	.....	.....	Cu.....	Sn., Ag., Pb., S.
858	"	"	.....	.....	Cu.....	Sn., Ag., Pb., S.
4264	"	"	.....	.....	Cu.....	Sn.

PERU (*Continued*).

Cat. No.	Locality.	Object.	Cu.	Sn.	Present.	Absent.
4265	Trujillo	Spear point			Cu	Sn., Ag., Pb., S.
4291	Chimbote	Agricultural impl.			Cu	Sn.
4292	"	"	93.04	7.01		Pb., S.
4293	"	"	96.00	4.00		
9349	"	"	94.71	4.57	trace Au., Fe	Pb., Ag., Ni., Zn.
9350	Chancay	Chisel	97.18	2.81		Pb.?
9193	Cuzco	Knife	92.15	7.45	trace S., Pb.?	Ag.
9194	"	"	91.50	8.53		Pb.?
9195	"	"	92.00	7.98		Pb.?
9196	"	"	93.94	5.76		Pb.?
9187	"	Ax	92.80	7.14		
9188	"	"	95.84	3.87		Pb.?
9202	"	Chisel	94.61	4.23		Pb.?
9198	"	Topo	95.00	4.96		Ag., Pb., S.
9199	"	"	95.36	4.58		Pb., Zn.
9190	"	Llama figure	91.50	8.54		Ag., Pb., S.
9189	"	"	98.00	2.02		Ag., Pb., S.
9205	"	Deer figure	96.19	3.71		Ag., Pb., S.
9191	"	Bola	90.05	9.64		Ag., Pb., S.
9206	"	Human figure	97.80	2.15		Ag., Pb., S.
9208	"	"	98.00	1.97	trace Pb.?	Ag., S.
9210	"	"			Cu., Ag., trace S.	Sn.
4291	Chimbote	Agricultural impl.			Cu	Sn.
4292	"	"	93.04	7.01		Pb., S.
4293	"	"	96.00	4.00		
9349	"	"	94.71	4.57	trace Au., Fe	Pb., Ag., Ni., Zn.
9350	Chancay	Chisel	97.18	2.81		Pb.

9615	Cajamarca	Knife	94.33	5.67		
9196	"	"	93.94	5.76		
4598	Ancon	Chisel	94.90	5.16		
4599	"	"	94.38	5.62		
1253	Surco	"			Cu.	Sn.

BOLIVIA.

Cat. No.	Locality.	Object.	Cu.	Sn.	Present.	Absent
2791*a*	Tiahuanaco	Knife	93.80	6.17		Ag., Pb., S.
2791*b*	"	"	94.50	5.43		
2794	"	"	92.11	7.79		
2796	"	"	96.41	2.73		
2797	"	Topo	91.70	8.32		
2800	"	"	88.00	12.10	trace S.	Ag., Pb.
2804	"	"	92.00	7.94		
2793	"	Ax	95.92	3.27	trace Fe.	Ag., Pb., Ni., Zn.
2821*a*	"	Pendant	92.50	7.46		Ag., Pb., S.
2821*b*	"	"	89.40	10.59	Pb., trace S.	Ag.
2821*d*	"	"	99.22	1.28		Pb.
N-760	"	"	94.70	5.15		Pb.?
2792*a*	"	Clamp			Cu.	Sn.
2792*b*	"	"			Cu., trace S.	Sn.
2792*c*	"	"			Cu.	Sn.
2792*d*	"	"			Cu.	Sn.
2791*e*	"	"			Cu.	Sn.
2639	Copacabana	Topo	87.4	12.68		Ag., Pb., S., Zn.
2641	"	"	94.24	5.76		Pb.?
2642	"	"	94.07	5.21		Pb., S.

BOLIVIA (*Continued*).

Cat. No.	Locality.	Object.	Cu.	Sn.	Present.	Absent.
2643	Copacabana	Knife	90.30	9.76		Ag., Pb., S.
2644	"	"	98.30	1.71		
2652	"	Topo			Cu., trace Sn	
2752	"	Long Chisel	93.75	6.29		Pb.?
2645	"	Topo	92.50	7.56		
1846	Isl. of Titicaca	Battle Ax	90.00	10.02		S.
1806	"	Knife	97.00	3.06		Ag., Pb., S.
1807	"	"	94.70	5.29		Ag., Pb., S.
2068	"	"	93.70	6.32		Ag., Pb., S.
2485	"	"	93.43	6.57		Pb.
2486	"	"	90.00	9.12		Pb., Ag., As.
1950	"	"	96.70	2.03	Pb. 0.41	
1961	"	Topo	89.40	10.62	trace S	Ag., Pb.
1965	"	"	98.40	1.65		Ag., Pb., S.
1998	"	"	95.80	4.13	trace S	Ag., Pb.
1949	"	"	91.00	4.00	Pb. 6.00	
1947	"	"	99.10			Sn.
2065	"	"	97.00	3.00		
1782	"	"	95.16	4.13	trace Pb	
3115	"	"	92.38	3.87	trace Pb	
3286	"	"	95.41	3.86		
1838	"	?	97.82	1.39	Pb	
1955	"	"	93.67	6.35		
1845	"	"	97.12	1.70	trace Fe	Pb., Ag., Ni., Zn.
1841	"	Cutting tool		trace	Cu., trace Au	Pb.
3037	"	Ax	93.70	6.20		Pb., S.
1952	"	Ax or Chisel			Cu	Sn., Ag., Pb., Zn.

1805	" ...	Chisel	.....	.....	Cu.....	Sn.
1819	" ...	"	.....	.....	Cu., trace S.....	Sn., Ag.
1839	" ...	"	.....	.....	Cu.....	Sn.
2046	" ...	Bola	94.00	5.00	Pb.....	
2045	" ...	"	88.65	7.26	trace Pb.....	
2047	" ...	"	96.00	4.00	.....	
1835	" ...	"	99.10	.....	trace Sn.....	
1834	" ...	"	97.50	2.48	.....	Ag., Pb., S.
2094	" ...	"	93.70	6.33	trace S.....	Ag., Pb.
2413	" ...	Drill-like tool	94.45	4.53	Pb.....	
1729	" ...	Plume	88.51	9.07	.....	Pb.
2428	" ...	Tweezers	99.12	.....	trace Sn.....	
2399	" ...	Disc	99.12	.....	.....	Sn.
1956	" ...	Needle	96.00	4.00	.....	
1943	" ...	"	98.50	.....	.....	Sn.
3314	Pen. of Huata.	Topo	96.00	4.00	.....	Pb., S.
3347	" ...	"	90.34	6.85	.....	Pb.?
3114	" ...	"	88.91	9.48	trace Pb.....	
3286	" ...	"	88.01	8.03	Pb. 3.04.....	
3130	" ...	"	92.26	6.17	trace Pb.....	
3270	" ...	"	88.20	10.50	.....	Pb.
3349	" ...	"	91.90	4.75	trace Pb.....	

TABLE II. BY DRS. MORRIS LOEB AND S. R. MOREY.

Cat. No.	Locality.	Object.	Cu.	Sn.	Pb.	Fe.	S.	As.	Density
1842	Isl. of Titicaca	Chisel or drill	91.81	7.56	.....	trace	.....	.....	8.68
1840	"	Chisel	90.51	8.92	.....	trace	trace	.....	8.94
1959	"	"	95.59	4.48	.....	trace	.....	.....	8.92
2413	"	Drill (?)	94.96	4.98	.....	.....	0.53	.....	8.61
1949	"	Chisel	91.43	7.05	.....	trace	.....	.....	8.18(?)
859	Chan Chan	Spear-point	97.43	.....	trace (?)	trace	little	2.14	8.98

TABLE III. BY PROFESSOR S. P. SHARPLES.

Cat. no. 8710.	Ornament from Ancon.	Copper with trace of silver
" 7322.	Tool " "	Copper
" 8868.	Pin from Palasgache.	Copper, 89.21 — Tin, 10.48 — Iron, Silver &c., .31
" 16420.	Tweezers from Pacasmayo.	Copper, 83.21 — Silver, 16.79
" 10000.	Group of Figures. Chimbote.	Copper, 85.56 — Tin, 13.21 — Iron, 1.23

Figure 1.

Types of Implements from the Island of Titicaca, Bolivia.

Fig. a (1956) shows a needle, $4\frac{7}{8}$ in. long. It contains 4 percent of tin.

Fig. b (1846) is a battle ax. This form, which is not uncommon, is a modification of the six-pointed or morningstar club head, so common in both stone and metal. In this case one of the points was flattened out into the form of an ax blade. It was cast in a mould, and the blade hammered into shape. The percentage of tin is 10.02.

Figs. c, d, e (2046, 2045, 1834) are bolas, containing respectively 5, 7.26, and 2.48 percent of tin. Each has a hollow space inside with a cross-bar to which the cord was attached. The bola, as used by the Peruvians for hunting consisted of three balls of stone or metal united by thongs to a common center. One of the balls is smaller than the others, and this one was held in the hand, and the other two whirled about the head. When released a bola goes revolving through the air, and on striking the legs of an animal it winds around them, and brings him down.

Figs. f, g (1998, 1782) show topos or pins, used to hold a shawl-like garment together at the throat. In the head of these pins are perforations for cords. Such pins were often made to do double duty. The two shown here have the upper edge of the head sharpened, and were used as knives. Often the head was in the form of a spoon, and doubtless used in eating the ground parched corn, which was and is one of the favorite foods. Both pins contain 4.13 percent of tin.

Fig. h (2486) is a knife, $5\frac{1}{2}$ in. high. A portion of the blade is missing. The handle terminates in a well-formed hand. It was cast, and the blade hammered. It contains 9.12 percent of tin.

Fig. i (1839) is a chisel-like implement. Its cutting edge is at the lower end; the upper end is made larger that it might be held firmly in the hand. Such implements often have this end extended out on both sides, like the top of the ax shown in Fig. 3b. Analysis shows this implement to be of nearly pure copper.

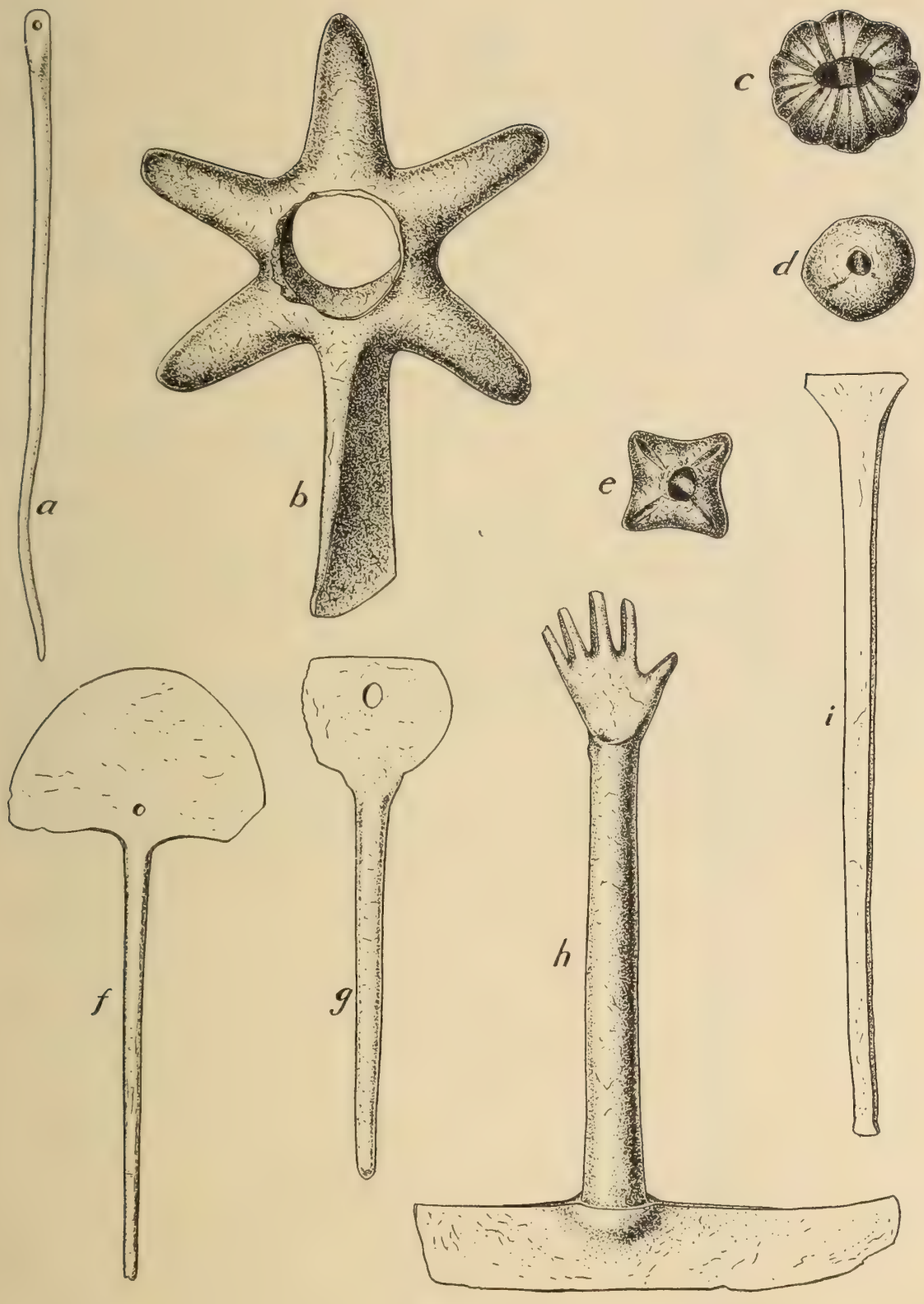

Fig. 1.

FIGURE 2.

Types of Implements from Tiahuanaco, Bolivia.

Fig. a (2797) shows a topo or pin with its head perforated for suspension. It contains 8.32 percent of tin.

Fig. b (2791a) is a common form of the Peruvian knife. The tip of the handle is missing in this specimen. The percentage of tin is 6.17.

Figs. c, d, e (2821d, 2821b, 2821a) shows a form of pendant that seems to be peculiar to Tiahuanaco, and not found at any great distance from that place. They contain respectively 1.28, 10.59, and 7.41 percent of tin.

Figs. f, g (2792b, 2792e) are copper clamps. They are used to hold the blocks of stone together in some of the buildings in Tiahuanaco, and have been found in no other locality. They are about 5 in. in length, and are without a trace of tin.

Fig. h (2794) is a topo or pin, $4\frac{1}{2}$ in. long. It is perforated for suspension, and is a good example of the double use of such pins, as its head is shaped like a Peruvian knife. The upper surface has been brought to a cutting edge. Percentage of tin 7.79.

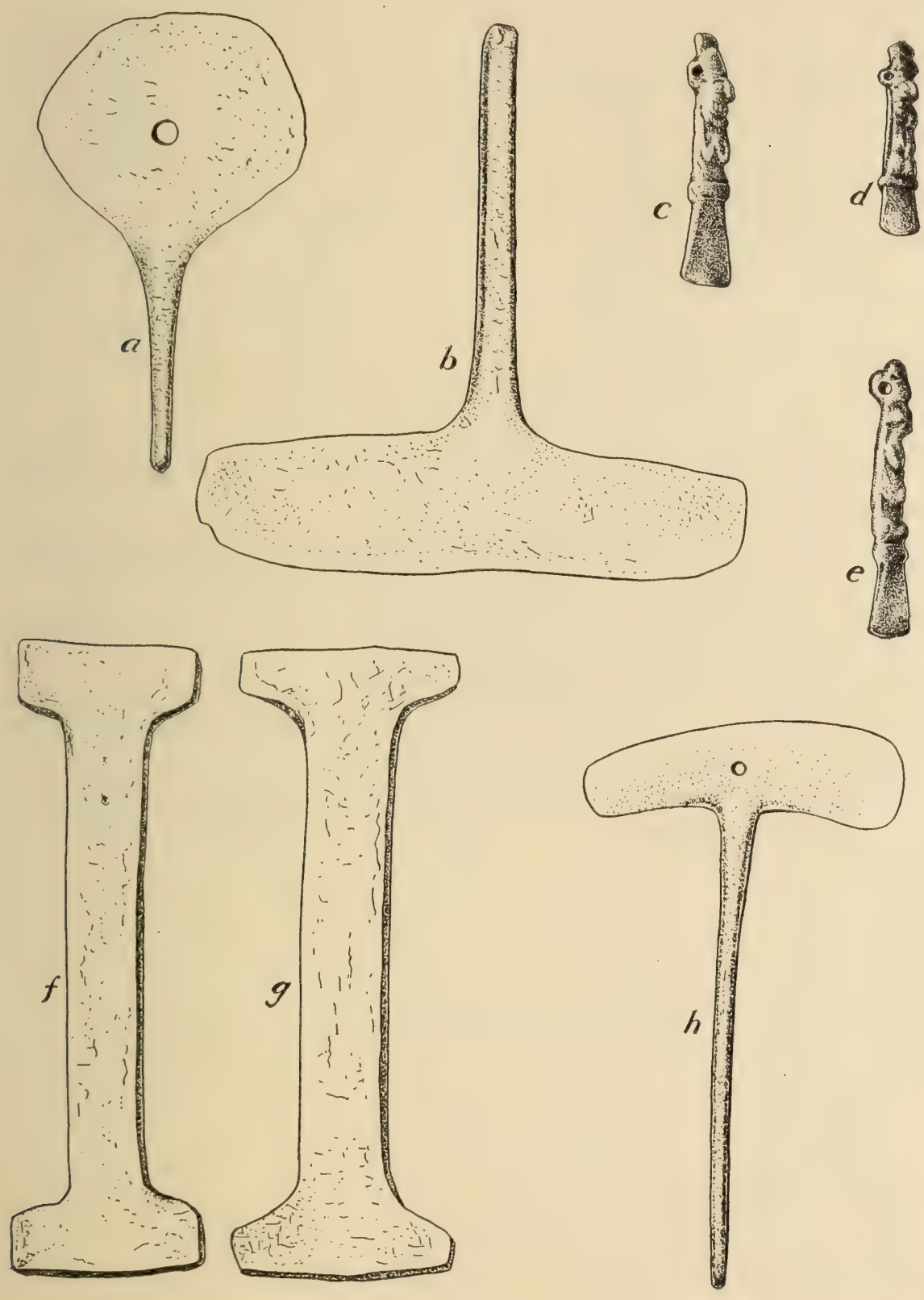

Fig. 2.

FIGURE 3.

Typical Objects from Cuzco, Peru.

Fig. a (9189). Cast figure of a llama. Such figures were buried in the fields where the llamas grazed as a prayer or charm for the increase of the flock. This specimen contains 8.54 percent of tin.

Fig. b (9188) is an ax or hatchet with the upper part extended out on both sides, which made the attachment of a handle an easy matter. It was cast and hammered, and contains 3.87 percent of tin.

Fig. c (9191) is an odd form of bola, containing 9.64 percent of tin. It was used in the same way as the balls shown in Fig. 1c, d, e.

Fig. d (9187) shows a battle ax. It is $3\frac{13}{16}$ in. high; the blade $5\frac{1}{8}$ in. long. Like the other implements described this shows plainly the marks of having been cast in a mould. The percentage of tin is 7.14.

Fig. e (9202) shows a very common form of chisel, $3\frac{7}{8}$ in. long. It is battered and turned over on both ends as if used on stone. It was cast and hammered, and contains 4.25 percent of tin.

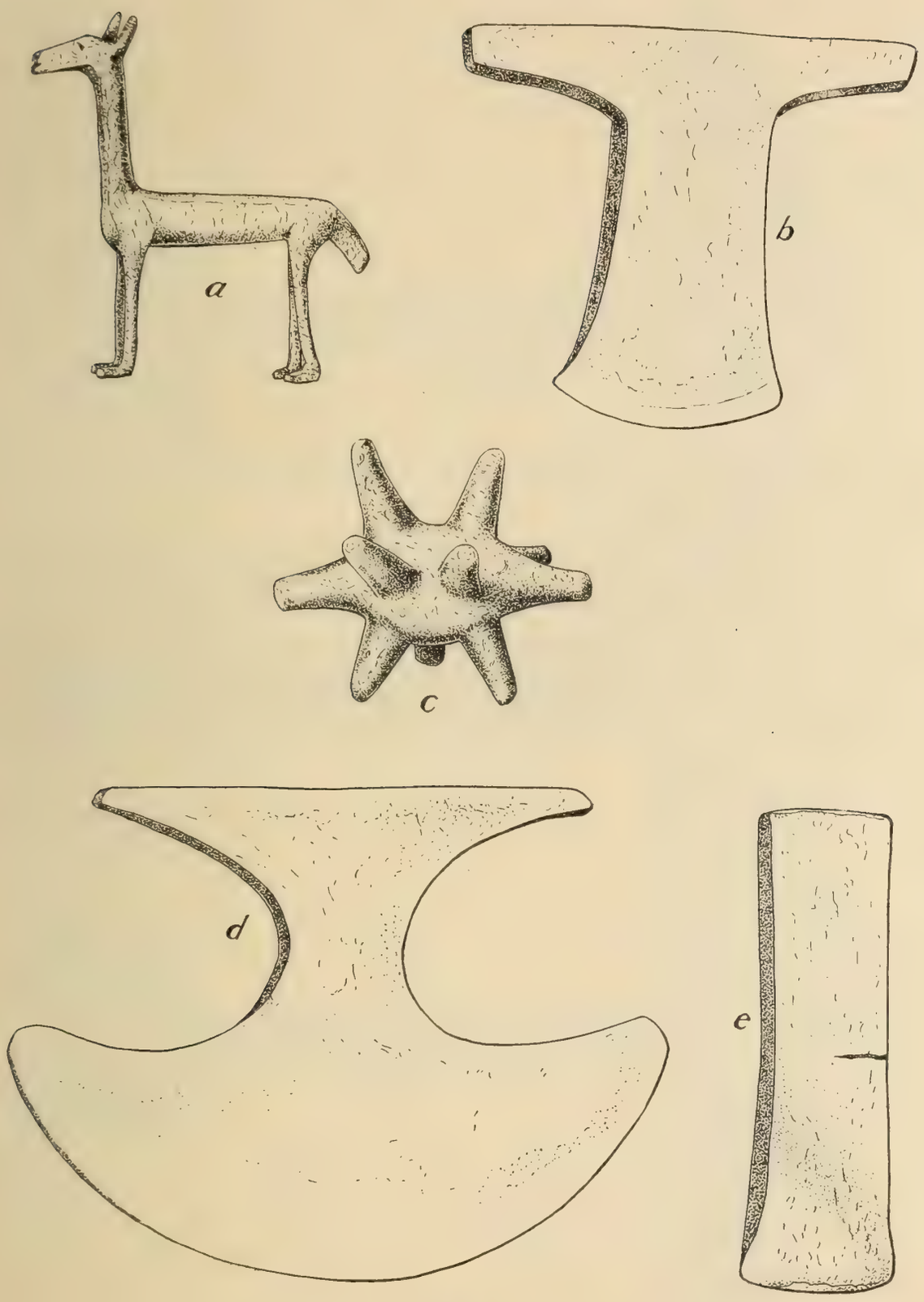

Fig. 3.

FIGURE 4.

Three fine Knives from Cajamarca, Peru. They have been cast in moulds, and the blades have been hammered.

Fig. a (9615) is $6\frac{5}{8}$ in. high, and the blade $4\frac{5}{8}$ in. long. Two human figures rest on the cross piece of the handle. This knife contains 5.67 percent of tin.

Fig. b (9196) is $4\frac{3}{8}$ in. high, the blade $1\frac{7}{8}$ in. long. The handle ends in a llama's head; a very truthful and spirited representation, and one of the most artistic castings in the collection. The amount of tin in this specimen is 5.76 percent.

Fig. c (483) is $5\frac{7}{8}$ in. high; the blade $4\frac{1}{2}$ in. long. On the cross piece of the handle, facing each other, are a man and one of the great cats. This specimen has not been analyzed.

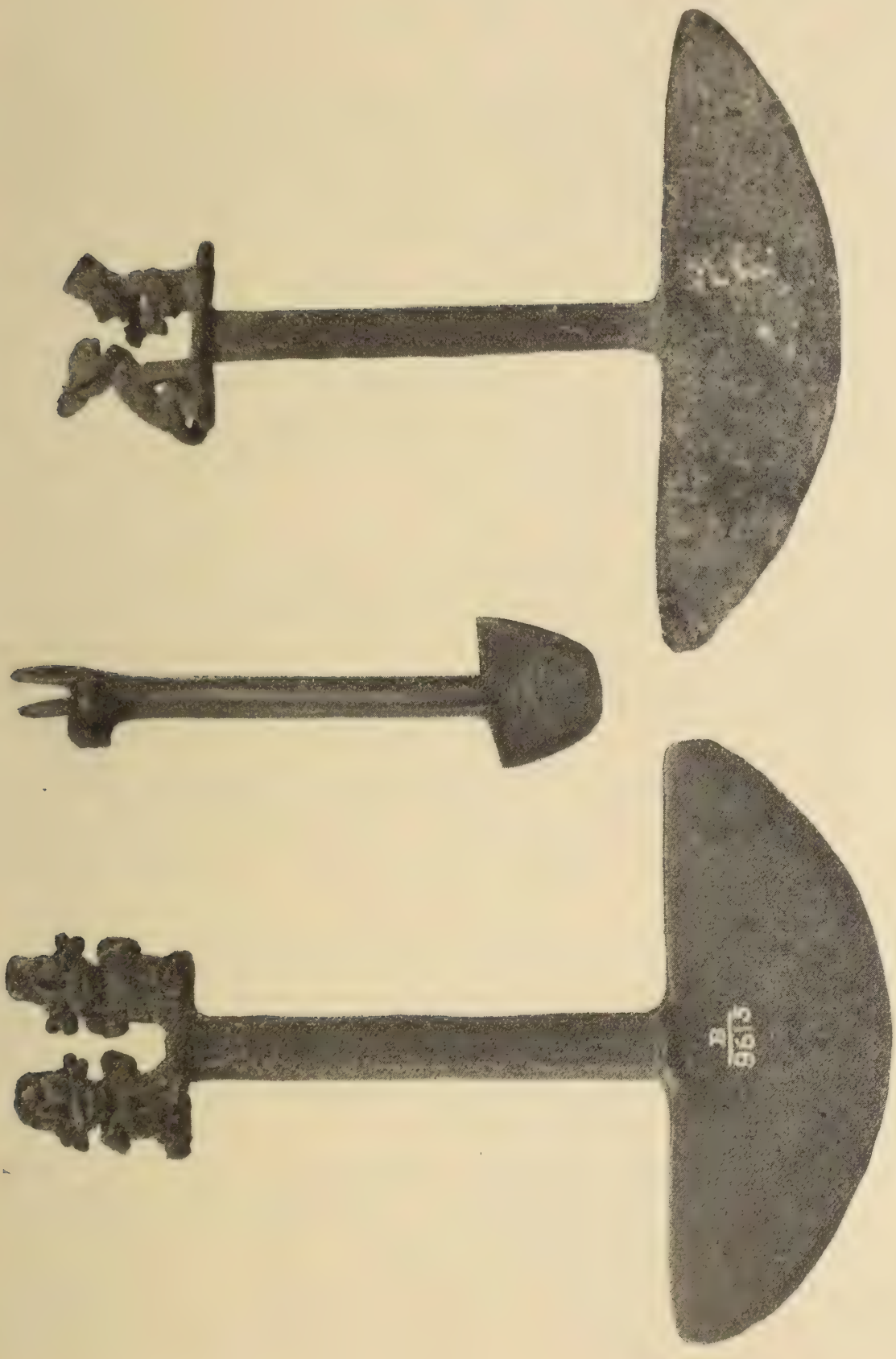

Fig 4.

The implements and ornaments of bronze which have been found in such large numbers in the prehistoric burial places within the boundaries of the ancient Peruvian Empire have caused much difference of opinion and discussion as to whether the mixture of copper and tin, the component parts of bronze, was intentional or purely accidental. In other words, did the copper which they mined contain among its other impurities tin in such quantities as is found in these objects by analysis, or were the two metals separately procured and smelted together with the intention of producing a harder metal. In the following pages I propose to review such evidence as we have at the present time bearing on this question.

The early historians, Garcilasso de la Vega and Father Barba, state positively that the Indians were acquainted with the secret of making bronze. Garcilasso tells us: — "They worked with certain instruments they had made of copper, mixed with a sort of fine brass." [1] At the time the Inca historian wrote tin was often called brass, not only in South America but in Europe as well. Confusion in the names of metals is an old one for we read in Sir John Lubbock that, "In the Pentateuch, excluding Deuteronomy, bronze, or as it is unfortunately translated, brass, is mentioned thirty-eight times." [2]

Early in the seventeenth century the Licentiate Alvaro Alonso Barba published his "Arte De Los Metales." In Chapter XXXIV of this work entitled "On Metals and Artificial Metallic Articles" I find the following paragraph: —

> Art also has its metals, and a multitude of manufactured metallic articles imitate the beauty of nature. From a mixture of tin and copper is made the bronze for balls, pieces of artillery and other articles. One pound of tin is taken, and from four to eight pounds of copper, according to the variety of the tin. The Indians knew of this mixture, and used it to give hardness to their instruments and arms, as we use steel or tempered iron, which were unknown to them.

Father Barba combined with his sacred duties, as priest, that of the office of director of the mines; his Parish of San Barnado being situated in the very heart of the mining district of Bolivia.

The book from which I have quoted above enjoyed a great reputation in his time on account of his attainments as a metallurgist and his knowledge

[1] Royal Commentaries, Book II, Chap. XVI.
[2] Prehistoric Times, 5.

of the mining industry. His intimate relations with the Indians, as priest and mine director, previous to 1639, should give great weight to his statement that the Indians knew the secret of mixing tin with copper to harden their arms and tools. Another circumstance that should be taken into account in estimating the value of his statement is the great probability that the parents of some of his Indians must have been living at the time of the Conquest, and the facts in the case well known in his day.

The edition of "Arte De Los Metales" published in Madrid in 1639 is now one of the rarest of books, and I have been informed that a short time ago but two copies were known to exist in South America. One of these lately came into the possession of Mr. E. P. Mathewson, the well known metallurgist and manager of the Anaconda Copper Mining Company of Montana. Mr. Mathewson knowing that I was interested in the subject of prehistoric bronze in South America very kindly loaned me the book with permission to make use of it any way that would further my studies in that direction.

During my researches I have often met with mention of Barba's work, usually followed by the remark: "not available to the author." A translation of a part of the title page will show the general character of the book. "The Art of Metals wherein is taught the true process of working Gold, Silver, Quicksilver. The manner of melting them, and how they should be refined and separated one from the other."

Chapter XXXII deals with tin, and believing that it will be of interest to the many who have been unable to see the book, I give a translation of it in full below:—

Many call white lead what we call tin, and this name is also given by those who separate Silver from Copper to the Lead that is found mixed with Silver, as will be explained further on, owing to its white appearance and to the harshness that is felt when it is bitten or broken. Common tin is produced by the same principles as Lead, but more purified and clean, from which it obtains its greater whiteness and hardness, although from the poor mixture of its pastes it is called "stuttering" and causes the harshness above mentioned. It is the poison of metals, as all that get mixed with it, will turn brittle, because by its company, the equal mixture they had before, is perverted, and their ductibility, or expansion by the stroke of the hammer, is hindered.

Only Lead is free from this disadvantage, as with its excessive moisture and softness, it is penetrated and goes on with its badly mixed parts of tin, and both remain ductile. Tin materials are not common everywhere, but they are not scarce in these rich Provinces,— Famous is the District of Collquirino, distant from that of San Felipe de Austria of Oruro, for the great quantity of very good ores that have been taken out and are being taken, for all this kingdom, among the metals of which, as has already been observed, rich pockets of silver are often found. Near Chayanta, in the Charcas there is another Tin mine, which has been abundantly worked of late years. Not far from Carabuco, one of the towns bordering on the margin of the mag-

nificent Chucuyto Lake, toward the borders of the Province of Larecaxa, there are also mines of this metal which the Indians in the time of their Incas worked and afterwards were continued by the Spaniards. The veins are large and the metals rich of their kind; from among them some ores are also taken containing much silver, and all partake of some copper, and on account of this mixture this tin is more showy and hard. The fame of the richness of these veins, induced me to visit them, aside from the desire I have had of seeing and testing the ores of all these Provinces. In the hills of Pie de Gallo of Oruro there is much tin, although not known by many, and because no silver, which all seek, is found there, they pass them by. One of the four principal rich veins that deserved the name, among the great multitude of them that are found in this peerless Potosi Hill, is the one called the "Tin Vein" on account of the great quantity it had on the surface of the land and which lower down was converted into Silver, owing to the better arrangement of the substance found.

And in the district of the Parish of San Bernardo, where I serve at present, and a quarter of a league more or less from it, there are veins of very rich tin metal, which His Excellency, went personally to inspect, on information regarding same given by me, encouraging by this, as by many other actions, those that are engaged in the working of the mines, from which so much benefit accrues to the Royal Treasury of His Majesty, and for the good of his subjects.

The localities mentioned are in Bolivia, on the shore of the great lake of Chucuyto (Titicaca) or at no great distance from it. We are told the locality of several tin mines, and that large quantities of that metal had already been taken out.

It has been observed by Boman, Verneau and Rivet, and others that the proportion of objects of copper containing tin increases from north to south, reaching its maximum in Bolivia and the high plateau region of Peru. This contention is supported by the analyses given here. In these tables we find fifty-one objects from Chepen, in the northern coast region of Peru, and of this number but five contain more than a trace of tin, and only one of these over four percent of that metal. From Trujillo, also in the northern coast region we have eight specimens none of them containing a trace of tin.

From Cuzco, in the high central plateau region, sixteen objects, all but one of which contain tin, the average being 5.50 percent.

From Bolivia seventy-two analyses showing that fifty-nine of the objects are of bronze, averaging 6.24 percent of tin.

Of the seventeen specimens from Tiahuanaco twelve are of bronze, averaging 6.50 percent of tin. The other five, which contain no tin are the clamps used to hold the stones of the buildings together. Adrien de Mortillet [1] gives the analyses of six objects from Tiahuanaco. Two of these are clamps, and have not a trace of tin, while the other four pieces are bronze, averaging 6.56 percent of tin.

[1] Paper presented at the Premier Congrès Préhistorique de France, 1905.

Of the twenty-five analyses given by Boman [1] of objects from Peru and Bolivia sixteen show tin in quantities ranging from 2.10 to 11.42 percent. None of these bronze pieces show a trace of silver.

In the table of analyses by Mr. Wissler we find eighty-three specimens of bronze and as none of these contained silver I think we may safely conclude that the alloy was cassiterite or oxide of tin.

The Peruvian bronze problem was taken up in a very interesting and instructive way by Messrs. H. W. Foote and W. H. Buell [2] in their investigations as to the composition, structure and hardness of three bronze axes obtained by the Yale Peruvian Expedition, under Professor Hiram Bingham in 1911.

Messrs. Foote and Buell say: —

We have determined, first the chemical composition of the axes; second, their micrographic structure, and third, their hardness. By comparing the structure of one of the axes with that of a new alloy of the same composition, we have been able to draw conclusions as to the methods used originally in making the axes.

The following results are given: —

	1	2	3
Tin	12.03	5.58	3.36
Copper	88.06	93.94	96.44
Iron	0.08	none	trace
Silver	none	0.65	none
Sulphur	0.35	0.08	0.23
Lead	none	trace	none
	100.52	100.25	100.03

Ax no. 1, containing 12 percent of tin, was taken for comparison as being more interesting than the others from a metallurgical standpoint. A bar of metal was cast, containing 88 parts of copper and 12 of tin, and from this a new ax was forged. It was found that this could only be done at a temperature above 500° C. and either forged hot or quenched suddenly and forged cold. If heated and allowed to cool slowly the alloy was extremely brittle and broke in pieces under the hammer.

The authors say: —

The original ax no. 1, shows from its shape and from the marks on it that it has been forged. The original shape of the casting cannot be told, but there can be no doubt that the shape has been materially changed by the forging.

In conclusion they remark: —

Taking into account the facts of micro-structure and that the ax has been forged, it is fair to infer that after casting the original alloy, it was heated to a temperature

[1] Antiquités de La Région Andine, Table facing p. 868.

[2] The American Journal of Science, Aug., 1912, pp. 128–132.

considerably above 500° C. and either forged hot or quenched suddenly and forged cold. This required a very considerable degree of skill on the part of the original makers.

Bolivia has for years ranked second only to the Malay Peninsula in its output of tin, and may today be the greatest tin producing country of the world. Bolivian tin is for the most part found in the form of cassiterite or oxide of tin.

Father Barba, in his chapter on tin, names Carabuco as one of the localities where the Indians had obtained this metal. David Forbes, under the heading of — Cassiterite-Carabuco-Bolivia — says: —

Tin ores occur extensively in the province of Laricaja in northern Bolivia, on the west slope of the High Andes range close to the eastern shore of Lake Titicaca, at Carabuco. They occur here associated with several minerals containing silver, and in the time of the Spaniards were worked exclusively for the nobler metal: of late years, however, the deads of these mines have been and still are worked for tin. The tin ore is in the greatest part cassiterite, which occurs crystallized in prisms, having a specific gravity of 6.4. Mr. Philip Kroeber has forwarded me the subjoined results of his analysis of these crystals.[1]

Water	1.737
Tin	76.805
Oxygen	19.534
Iron	2.177
Silver	0.015
Tungstic acid	0.020
Lead	0.250
	100.538

It was also an easy matter for the Indians to have collected considerable quantities of cassiterite from the sands of many of the Bolivian rivers by washing. In these sands it generally occurs in semi-rounded nodules, and is easily reduced.

The ancient Peruvians melted their ores in cylindrical pottery furnaces, called *Guayras*. Garcilasso says: —

Neither did they know how to make Files or Graving tools, or Bellows for Melting down Metals; but instead thereof used Pipes made of Copper, of about a Yard long, the end of which was narrow, that the Breath might pass more forcibly by means of the contraction. And as the Fire was to be more or less, so accordingly they used eight, ten or twelve of these Pipes at once, as the quantity of Metal did require. And still they continue this way, though our Invention of Bellows is much more easier and forcible to raise the Fire. Nor had they the use of Tongs to rake their heated Metal out of the Fire, but rather drew it thence by a piece of Wood, or some

[1] Philosophical Magazine, vol. XXX, p. 141, 1865.

Bar of Copper; with which they cast it into a heap of wet Earth, which they kept purposely by them to cool their Metal, until such time as they could take it into their hands.[1]

The Museum's Peruvian collections contain two of the copper pipes described by Garcilasso. These are 31 and 25 inches long respectively. They are both made of rather thick sheet copper and have at one end a tunnel-shaped mouthpiece about $3\frac{1}{2}$ inches in diameter at the rim. This part was made separately by bending the sheet copper into the desired form and then hammering or welding the edges firmly together. This mouthpiece was welded to the tube which was made by bending the copper into the cylindrical form. In this case the edges are nicely brought together, but not welded. The outside of the tube shows how these edges were held together, for the marks of a closely wound cord of some kind are plainly to be seen from the mouthpiece to within half an inch of the end that was inserted in the clay furnace.

Dr. Daniel Wilson in his well known work on Prehistoric Man [2] gives the following analyses of American bronze objects: —

No.	Locality	Copper	Tin	Iron
1	Chisel from silver mines, Cuzco	94.	6.	
2	Chisel from Cuzco	92.385	7.615	
3	Knife from grave, Atacama	97.87	2.13	
4	Knife from grave	96.	4.	
5	Crowbar from Chile	92.385	7.615	
6	Knife from Amaro	95.664	3.965	0.371
7	Perforated ax	96.	4.	
8	Personal ornament, Truigilla	95.440	4.560	
9	Bodkin from female grave, Truigilla	96.70	3.30	

No. 1. Humboldt — No. 5. Dr. T. C. Jackson
2. Dr. J. H. Gibbon — 6, 7. Dr. H. Croft
3, 4. J. H. Blake, Esq. — 8, 9. T. Ewbank, Esq.

These scattered analyses, collected by Dr. Wilson forty years ago, are familiar to most archaeologists. While no attempt has been made to collect published analyses it was thought best to include this table, for comparison, as the names are all those of well known persons, and the figures have been so often quoted.

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[1] Royal Commentaries, Book II, Chap. XVI.
[2] Vol. 1, p. 254, London, 1876.

ARGENTINA.

Prof. Juan B. Ambrosetti has given much time and careful study to the prehistoric objects of bronze in Argentina, particularly to those from the Calchaqui region. As this region lies just south of Bolivia, and so many of the bronze objects found there are identical in form with those of Peru and Bolivia, any information that he has collected concerning their manufacture would apply equally well to the bronzes of the region we are studying.

In his work on bronze [1] Prof. Ambrosetti gives analyses of sixteen bronze discs. The amount of tin in these objects ranged from 1.57 to 8.67 percent; the average being 3.60 percent. These discs are of various diameters and are ornamented with embossed designs. Besides these discs he also gives the analyses of a knife, and five hatchets, containing respectively 3.80, 7.38, 6.06, 3.34, 5.73 and 6 percent of tin. These with the sixteen discs make a total of twenty-three objects analyzed with an average of 4.10 percent of tin. Whence came the tin in these objects? Prof. Ambrosetti states that there is still a doubt if that metal exists in Argentina, but quotes from the Memoirs of the National Department of Mines and Geology (1893–4) the analysis of a specimen of mineral from Cordoba reported as containing 2.16 grammes of tin to the 1000 kilos.

F. L. and E. Hess state that cassiterite has been reported near Tinogasta, in Rioja Province, in the department of Chicoana, La Poma and Province of Salta.[2]

Belief in the absence of tin, or at least its presence in but very small quantities, has lead some archaeologists to the conclusion that either cassiterite was brought from Bolivia or that the objects themselves were importations from that country. The latter theory is now known to be incorrect.

Dr. Francisco P. Moreno in his "Notes on the Anthropogeography of Argentina" says: — "In San Fernando and Corral Quemado I had proof that the bronze implements which are frequent in the Calchaqui graves, were not foreign, but were smelted and cast on the spot. I discovered some casts and the slag from the melting pot." [3] At Antofagasta de la Sierra he relates: — "In the time of former settlements there were cornfields and irrigating channels, while among the ruins of the town, and in the black lava, I have discovered foundries, and small melting-pots and broken casts for the beautiful bronze discs." [4]

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[1] El Bronce en la Region Calchaqui, Buenos Aires, 1904.
[2] Bibliography of the Geology and Mineralogy of Tin, Washington, 1912.
[3] Geographical Journal, Vol. XVIII, p. 586.
[4] Idem, p 588.

Martin de Moussy,[1] quoted by Ambrosetti, states that in the Potrero Grande there are copper mines which have been worked from remote ages. That the Indians, before the Conquest, extracted the metal to make their weapons and agricultural implements; and that in the hamlet of Jagüe he discovered the ruins of rude furnaces that had been constructed by the ancient inhabitants, with dross evidently produced by fusion on the spot.

Prof. Ambrosetti figures two pieces of slag — "personally extracted from ruins during my expedition of 1896." [2] One he found at Fuerto Quemada and the other at Tolombón. These were analyzed by Dr. J. J. Kyle with the following result: —

	No. 1	No. 2
Copper	96.80	95.60
Tin	1.34	3.22
Arsenic	0.40	———
Iron	trace	trace
Carbonic Anhydride	1.46	1.18
	100.00	100.00

The finding of furnaces, melting-pots, moulds for casting, and slag in the ancient ruins makes it certain that the bronzes were cast on the spot, and thus disposes of the theory of their foreign origin.

CHILE.

In Chile bronze objects, while by no means as common as in Peru and Bolivia, are found in considerable numbers and in various localities. Chile is abundantly supplied with copper, but as far as is known there is little or no tin in the country.

F. L. and E. Hess [3] quote A. Götting as follows: — "Cassiterite occurs in a diabase in which are also deposits of cinnabar, siderite, copper minerals and gold. The tin is apparently not in commercial quantity." Gilliss [4] gives analyses of fifteen varieties of copper ore found in Chile, and not one of them shows a trace of tin.

Alfred Wilhelm Stelzner, an eminent authority says, "if we turn to

[1] Description géographique et statistique de la Confédération Argentine, Paris, 1860, tome II, p. 395.

[2] El Bronce en la Region Calchaqui, p. 184.

[3] Bibliography of the Geology and Mineralogy of Tin, p. 55.

[4] U. S. Naval Astronomical Expedition to the Southern Hemisphere.

Chile we find no tin mining, nor a single reliable account, even of the smallest amount of tin having been found there." [1] Here again, as in the Calchaqui region, according to our present knowledge, copper exists but no tin, or at least in very small quantities. Did the prehistoric people of Chile work tin mines of which we are ignorant, or had they discovered copper ores containing as high a percentage of tin as the Cornwall coppers, of which nothing is now known; or did they obtain their tin from their northern neighbors? This presents one of the important historical problems of our subject to which we must now give some attention.

GENERAL DISCUSSION.

"Copper and its Alloys in Prehistoric Times," [2] the subject of the presidential address of W. Gowland before the Anthropological Institute of Great Britain and Ireland, seems to me to deserve more than ordinary attention of those who are trying to solve the problems of prehistoric bronzes. His position as Professor of Metallurgy at the Royal School of Mines gives his statements much authority. Following are a few excerpts from his address: —

> The camp fire was, I hold, the first metallurgical furnace. Pieces of ore which among the ring of stones enclosing the fire, or which accidently were embedded in its embers, would become reduced to metal. The cakes or lumps so produced would naturally attract attention of primitive man, and if he attempted to fashion them, as he was accustomed in making his implements of stone, he would then become acquainted with their curious properties of malleability and toughness, wanting in his customary materials, and so be lead to apply them to practical use.
>
> Furnaces were built in high places exposed to the wind, the air forced by a breeze through the apertures between the stones, giving rise to a sufficiently high temperature for the reduction of the metal, and no artificial blast was needed.
>
> Then as regards the metallic ores which were within the reach of prehistoric man, they were undoubtedly those which occur at the surface of the ground, i. e., when a mineral vein outcrops or is exposed. Now the ores which occur in this part of a vein are as a rule oxides and carbonates, which of all ores are most easily reducible to metal, and from all these metals can be obtained without any difficulty whatever by treating them in the primitive "hole in the ground" furnaces we have considered.
>
> So that when once the discovery was made that, simply by heating stones of a certain colour and weight, metal could be obtained, and when the possible applica-

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[1] Zeitschrift der Deutschen geologischen Gesellschaft, vol. XLIX, p. 76.

[2] Journal Anthropological Institute of Great Britain and Ireland, vol. XXXVI, pp. 11–38.

tions of the metal to useful purposes were also discovered, there would be, it is certain, a large production in the localities where these stones or ores occurred. Hence the vast amount of prehistoric metal objects which have been unearthed is by no means surprising.

The localities where these oxides and carbonate ores occurred must have been the centres whence the metal or metals were supplied to others, but it does not necessarily follow that in them, or even near them, the largest number of metal objects were always made, or should always be found, for the crude metal, more especially in later times, would often be merely an object of barter and would be worked into useful forms in more or less distant places.

It had been stated by a number of authors that bronze could not be produced by smelting a copper ore containing tin ore. Among others Sir John Lubbock [1] publishes the report of Alfred Jenkin, an experienced assayer, who experimented with the tin-copper Cornish ores and writes:—

> I do not think there are any Cornish ores which can be so smelted as to produce a mixed metal consisting only of copper and tin, and in such proportion as to form bronze: and for this reason, that although the ore may contain a sufficient proportion of tin, yet, as they also contain other ingredients, it would, I think, be impossible to get rid of all such ingredients without at the same time getting rid of the tin also.

Professor Gowland answers these statements by preparing a furnace of the "simplest primitive form, merely a hole in the ground." In this he smelted a mixture of copper ore (green carbonate) and tin stone, and obtained a copper-tin alloy. He says: —

> This experiment proves indisputably that when a copper ore containing tin ore was smelted by primitive man, a bronze consisting of copper and tin was obtained, and affords a complete refutation of the statements that such ores will only yield copper and not a copper alloy.
>
> We will now proceed to the consideration of the alloys, accidental and intentional, which were employed in prehistoric times. We will first consider the alloys which were the accidental result of smelting impure ore. In this category may be placed all those which contain less than about 1–2 percent of tin, although in exceptional cases a much larger percentage of tin may be accidental, as, for example, when the metal was obtained by smelting a copper ore rich in tin.

The following are some of the points made in Prof. Gowland's address: — He holds that in the early metal age the metals that are often present in copper have not been intentionally added, but are the result of smelting impure copper ore, but in somewhat later times when experience had shown that the addition of certain other metals to copper yielded a metal possessing more useful properties than copper ore alone, then these additions were made.

[1] Prehistoric Times, p. 608.

The term "copper" should be applied to all implements which contain 96 percent of copper and upwards, the remainder, 4 percent or less, being an assemblage in various proportions of two or more other metals, with occasionally sulphur; those containing two or more percent of tin to be excepted. That alloys containing less than about 1–2 percent of tin come within the accidental category, although in exceptional cases, as when Cornwall or other tin and copper ores were used, a very much larger percentage of tin may be accidental.

Verneau and Rivet say: —

One might object, it is true, that the presence of tin in the zones already mentioned is not intentional, that it is owing to the nature of the mineral employed. To this objection Boman answers that the only strata known here of native copper containing tin, and that in very small quantity, is that of Corocoro, in Bolivia, and if one admits that some parcels of crystals mixed with the copper ore would explain the presence of tin, in objects containing tin, this would not apply to some alloys where the metal exists in a proportion of 10 to 16 per 100, as is met with in Bolivia and the Argentine Republic. Sancho Dias expresses the same opinion.[1]

Weed says: —

The Corocoro mines have been worked from prehistoric times, but the production is only known since 1879. The copper is mainly native: but arsenates and glance occur. Domeykite (arsenic 28 percent, and copper 71 percent) occurs.[2]

David Forbes says: —

The well-known copper mines of Corocoro (Bolivia) are situated in the red sandstone of this formation and have been worked by the Indians from time immemorial. They were found in operation at the time of the Spanish conquest, and since then, up to the present date, have gradually increased in importance, notwithstanding that many of the mining and metallurgical processes are conducted in a manner more indicative of the times of the Inca dynasty than of the nineteenth century.

The Veta Remacoia, or main seam of copper is found to produce native copper, disseminated irregularly through a coarse grit, in grains, irregular lumps, or plates, sometimes of very considerable size. This seam is considered to have been the most anciently worked deposit of Corocoro, as it had been extensively worked by the Indians before the Spanish conquest.

The formation in which the Corocoro mines occur extends from Lake Titicaca southward nearly, if not quite, through Bolivia.[3]

As the bronzes from Bolivia contain the most tin I considered that country the best field in the old Peruvian Empire for investigation in an

[1] Ethnographie Anciénne De L'Equateur, p. 333.
[2] The Copper Mines of the World, pp. 180–181.
[3] Quarterly Jour. of the Geological Soc. of London, Vol. 17, pp. 40 and 42.

attempt to determine, as far as such things can be determined, the truth in regard to the controversy between those who believe in the accidental, and others who maintain the intentional theory of these bronzes.

Before beginning this study I had supposed it a comparatively easy matter to ascertain the composition of many of the Bolivian copper ores; but as I examined work after work on metals and mining, I became more and more astonished at the meager information they contained on this point. While I should have liked to have found analyses of a large number of Bolivian coppers, still enough information has been collected to convince me that these old implements could not have been made of a metal produced by smelting impure copper ores.[1]

In his "Story of Machu Picchu" [2] Professor Hiram Bingham figures quite a large piece of tin which he considers as perhaps the most important of his discoveries in that ancient ruined city, and remarks: —

> It has been generally supposed that the ancient peoples of Peru did not know how to manufacture bronze, but that all their bronze was accidental. This picture shows a piece of pure tin, which had apparently been rolled up by the Incas or their predecessors like a sandwich. From it, it is supposed, slices were cut when the artisan to whom it belonged needed tin in the making of bronze. It is a strong indication that the inhabitants of Machu Picchu knew how to make bronze.

In conclusion I should like to return to the subject of the copper clamps, or bolts as they have sometimes been called, from Tiahuanaco. It seems to me that in these objects we have a strong argument on the side of the intentional theory of Peruvian bronze.

Of the twenty-three objects from Tiahuanaco analyzed by Wissler and

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[1] Since writing the above I have received the following letter from Mr. R. M. Atwater Jr.: —

"Replying to your letter of the 22nd instant, I wish to say that I shall be very glad indeed to give you all the information I possess in regard to Bolivian mines, and shall take an early opportunity to call on you, in order to discuss the matter thoroughly. In the meanwhile you are perfectly safe in proceeding upon the ground that there does not exist in the mines of Bolivia any natural alloy of copper and tin, or either veins or placers where the two metals occurred within such proximity that their mixture could be accidental. Any race capable of making gold and silver ornaments, such as you have seen coming from Old Peru, were equally capable of smelting tin and alloying the same with the native copper. The discovery of native copper in stream beds was easy, although, no doubt, it gave rise to much disappointment when the finder discovered that the copper was not gold. The discovery of tin, however, must have been by a different method, since tin-stone has not a metallic appearance, and crushes to powder under the hammer. The discovery of its metallic nature must have been the result of a deliberate or accidental smelting operation."

Mr. Atwater has spent much time in Bolivia, and is familiar with the copper ores and copper mining in that country. He informs me that he has made some five hundred essays and analyses of Bolivian copper ores, and that they show no tin.

[2] The National Geographic Magazine, Feb., 1915.

by De Mortellet, all with the exception of the seven clamps are bronze, averaging over $6\frac{1}{2}$ percent of tin. The clamps are in each case of nearly pure copper, without a trace of tin. We must believe either that these were purposely so made, or that it was simply a coincidence; if the latter it is certainly a very remarkable one. Two of these clamps are shown in Fig. 2. I can conceive of but one other theory that could be advanced to explain the absence of tin in these clamps, and that is that they are much older than any of the other objects from Tiahuanaco that have been analyzed; that they were made before the discovery of bronze. This seems to me improbable.

Too much caution cannot be exercised in accepting published statements regarding prehistoric bronze implements from Peru. Authors otherwise reliable have been known to class all copper and bronze objects under the head of bronze, without the formality of proper tests. Thus in Squier's Peru [1] (p. 175), four agricultural implements are figured and labeled bronze. Two of these implements are in the Museum's collection, and their analyses will be found in the table by Wissler, under the catalogue numbers of 816 and 855. They are not bronze.

Posnansky gives three plates, containing forty-eight metal objects, all labeled bronze. One of his plates shows three of the clamps, which have just been discussed, and a portion of a fourth. In his text he says: "The material is tempered bronze by a process to-day not understood." [2] (El material es de bronce templado por procedimientos hoy desconocidos). As no chemical analysis is given, we are left to infer that it was taken for granted that they were of bronze, and were so labeled.

Authors who have advocated the accidental theory to account for these bronzes have always used as their chief reason for that belief the fact that such objects as knives or chisels often contain a smaller percentage of tin than some other pieces like spoons or such pins as have no cutting edge at the upper end. This argument loses entirely its force when we inquire into the condition under which these things were made, and the behavior of copper and tin when smelted together.

Dr. A. Snowden Piggot [3] in writing on the bronze statues of Alexander by the celebrated artist Lysippus, the three thousand bronze statues found at Athens by the Roman Consul Mutianus, and the many statues at Olympia and Delphi, says:

> It must not be supposed, however, that the ancients possessed the skill of the moderns in the management of this metal. Having no means of ascertaining with

[1] Incidents of Travel and Exploration in the Land of the Incas, New York, 1877.
[2] Monumentos prehistoricos de Tiahuanacu, La Paz, Bolivia, 1912.
[3] The Chemistry and Metallurgy of Copper.

certainty the actual composition of these alloys, they could not provide against the oxidation of the tin, and consequent refining of copper, which is one of the great difficulties in working this alloy. Consequently, analysis has shown that their bronzes are of very variable composition, some of them containing the proper quantity of tin, and others being nearly pure copper.

Indeed, this difficulty has not always been overcome in modern works. The statue of Desaic, in Place Dauphine, and the great column in the Place Vendome, are signal instances of failure in this respect. On analyzing, separately, specimens taken from the bas-reliefs of the pedestal of this column, from the shaft, and from the capital, it was found that the first contained six per cent of tin, the second much less, and the third only 0.21 per cent, being nearly pure copper.

It seems to me that these statements of Dr. Piggot explain satisfactorily the variation in the quantity of tin in Peruvian bronzes.

Finally, taking into consideration the positive statements of Garcilasso and Padre Barba that the Indians knew the secret of combining tin with copper to harden their implements, and after a careful study of the foregoing analyses, which show that the bronze objects contain very considerable amounts of tin, especially those found in Bolivia, where it is now pretty certain that the copper ores contain no tin; the discovery of a piece of pure tin in the Ruins of Machu Picchu; the finding of smelting furnaces, slag containing tin, and moulds for casting in Argentina where all known coppers have no tin in their impurities; and such facts as can be gathered concerning the composition of all copper ores in the region under discussion, we can but come to the same conclusion as did Boman, that "We must abandon the accidental theory." [1]

[1] Antiquités De La Région Andine, p. 866.

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PERUVIAN TEXTILES.

BY

M. D. C. CRAWFORD.

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PERUVIAN TEXTILES.

By M. D. C. Crawford.

PREFACE.

The object of this paper is to give some idea of the technical side of the fabrics found in the graves of Coastal Peru. The nature of design and color will be considered only in this relation. As far as possible, the analyses will follow the same lines as though the cloths were the product of modern looms. First, the nature of the fabric will be considered, that is, the manner in which the design is produced. Under this head will come the manner in which warp and weft cross each other, also the number of each contained in a square inch. Next the yarns themselves will be examined, first, as to the nature of the fiber; second, as to twist and ply. And lastly, the chemical properties of the dyes with relation to fastness and possible physical nature will be treated.

The fabrics selected to illustrate the different styles of weaving have been chosen solely to give the clearest examples in point. All of them are in the possession of the Museum, but not all of them are on exhibition. Most of the pieces in the cases are in nearly perfect condition and the rather rigorous nature of the analysis made the fragments, though unfit for exhibition purposes, much better adapted to the purposes of this paper.

Where this article treats of the analysis of any fabric or yarn, the observations have been carefully made and the statements are subject to proof. A microscope and a thread counter of the latest design have been used and in cases of great fineness, counts have been ascertained by picking off a full inch of weft under a dissecting microscope. In order to have clearness throughout, the counts of yarn have been determined by comparison with modern cotton yarns of known count, and, of course, refer only to comparative diameter. This system was applied to the wool and bast yarn as well as cotton. It was impossible to make the customary tests by weight and length. It was equally difficult to obtain the number of turns per inch on the modern machines for this purpose. The finest yarns being generally too tender, the method employed was to take a photomicrograph of yarn at a given multiple of the diameter, count the number of turns per inch and multiply by the number of times the original was magnified. I am aware of the objections to such a course, but no other presented itself and the wonderful evenness of these yarns makes such a test quite reliable. In selecting fibers for the photomicrographs an attempt was made to get an average staple.

One part of this paper deals with the actual mechanical movements required to produce the yarns and the fabrics. An effort has been made to reconstruct a technique that has been buried for centuries. Accounts of primitive spinning and weaving are extremely rare and seldom written by technical experts and such as I have read differ in essential particulars from the case in point. References in the Spanish commentaries are very meager and unscientific. Therefore, the only possible method has been to study carefully the tools found in the graves, consider the absolutely essential movements, and endeavor to ascribe to each its proper function. When it is borne in mind that certain of these yarns and fabrics have never been excelled, and that almost every known method of decorating a web of cloth has been used, the difficulty of such a task must be evident.

So far as known to the writer no one has yet taken up the study of Peruvian textiles in this way. Mention may be made, however, of some work by William H. Holmes, *Textile Fabrics of Ancient Peru*, Washington, 1889, and a paper by Max Schmidt, *Über Altperuanische Gewebe mit Szenenhaften Darstellungen*, "Baessler-Archiv," Band 1, Berlin, 1911. In the latter are several detailed drawings of looms and schematic diagrams of design technique. Yet, these investigators were concerned with other problems than those of textile technique using the latter only as an incidental means to an end. Hence, it seemed best for the writer to take the specimens themselves and subject them to the same methods now used in the critical evaluation of modern fabrics. In this he claims the indulgence due to a pioneer. If these lines arouse the interest these truly marvelous fabrics deserve, to the end that each phase of the subject be studied by experts, their object will be fulfilled.

So comprehensive is the range of Peruvian fabrics, that the writer did not feel competent to pass on all points. For this reason certain specialists were consulted. Thanks are due to Messrs. Douty, Boyé, and Lamb of the United States Conditioning and Testing Company for the photomicrographs of yarn and fiber and for Mr. Lamb's chemical report; to Mr. John Kimberly Mumford for information as to Oriental technique and fabrics which his great knowledge of the manufacture and history of rugs so amply qualifies him to give, and to Mr. A. J. Guthrie and Mr. M. C. Andrews of the John S. Brown Sons, manufacturers of fine linens in Ireland, who kindly examined the bast fiber cloths and furnished the analysis used in the text. Finally, the writer wishes to acknowledge his great obligation to Mr. Charles W. Mead, the Curator of the Museum's Peruvian Collections. We first took up this investigation at his solicitation and its progress has been in a large measure due to his kind and unfailing assistance.

June, 1915.

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INTRODUCTION.

In order that certain textile terms to be used later may be intelligible to readers unfamiliar with them, a brief description of modern spinning and weaving is given.

The actual processes, except such differences as the nature of the fiber entail, are the same in cotton as in wool. The cotton boll is a tangled mass of fibers attached to seeds. In fact, from two thirds to three quarters of the weight of the boll is seed. The first process is the removal of these seeds. This process is known as ginning and is performed in two ways. In the saw, or Whitney gin the bolls are placed upon an iron platform. Through slits in this platform revolve circular saws. These interstices are too narrow to allow for the passage of the seeds and as the rapidly revolving saws tear the fibers away a revolving brush cleans the teeth and removes the ginned cotton. This method is used with the great bulk of cottons, but the finer grades are ginned by a process slower in action and less destructive to the fiber. This is known as the roller gin. It removes seeds by the action of passing cotton between two cylinders back of which a moving blade gently presses out the seeds. Generally speaking, the finer cottons are the smooth seed varieties in which the staple clings less tenaciously to the seeds than in the common hairy seed species, and therefore allows for less destructive methods of ginning.

The next step, omitting bale opening, is picking, or scutching. Here the object is two-fold: removal of coarser dirt, broken seeds, sand, etc., and also the separation of the individual fibers from their natural tangled condition. This is accomplished by passing cotton over lattices, or grids, and beating it by rapidly revolving blades. Through these grids is driven a current of air sufficiently strong to force the cleaned and open staple forward, but not of sufficient strength to prevent the foreign matter from falling into the dust boxes below the grids. The product of the picker is a roll of cotton called a lap.

Cotton comes from the picker well opened and free from the larger impurities, but containing minute dirt and full of little tangles caused by broken and immature fiber, called nebs. Also the fibers are in a matted condition. The next process removes the last traces of dirt and nebs and also straightens out the fibers in approximately parallel relation to each other. This is called carding. The picker lap is placed before the card, where a rapidly revolving three-bladed knife, called the licker-in, draws the

cotton over a grid as in the picker, thoroughly cleans it, and then offers it to the action of the card cylinder and apron. The cylinder is covered with a cloth containing a great number of wire teeth. The same kind of teeth bent in the same direction are on the apron which is, in fact, an endless chain. The cylinder revolves at greater speed than the apron. Thus the cotton is gently pulled straight. The greater part of the nebs are taken up by the apron and removed by brushes revolving at the back. The carded cotton is removed by a smaller cylinder called the doffer, passes between a pair of rollers, through a trumpet-shaped guide, and is coiled in cans preparatory to the next process. The product of the carder is known as a sliver.

The object of the foregoing process is to thoroughly clean the staple and place the fibers in the same general direction. The next process is to attenuate the soft thick rope of fiber known as a sliver. The machines for this purpose are called draw-frames. They consist of three or four pairs of rollers. Sometimes both are fluted metal, sometimes the bottom roller is leather-covered and the top fluted metal. The speed of revolution of these rollers progressively increases until the last pair revolves nearly six times as fast as the first. This difference in speed attenuates the sliver and increases its length, but reduces its circumference. This attenuation is called draft. The product of the draw-frames is known as a drawing.

The next process is the first in which twist appears. The machines are known as fly frames. The drawing passes through a set of rollers which insert draft, then through the hollow leg of the flyer, and lastly are fastened to the bobbin. The bobbin and flyer are the same in principle as the spinning device on the old Saxony spinning wheel. That is, the wishbone-shaped flyer revolves around a revolving bobbin. Each is driven independently and one must exceed the other in speed. This causes the fibers to be twisted around a common center. There are three or four sets of fly frames. The amount of draft gradually decreases and the amount of twist gradually increases. The final product is called a roving.

When the fiber has reached this condition its final conversion into yarn may be effected by either the ring frame or the mule. The former is so unlike hand spinning that the description is unnecessary in this connection; but, in the mule the stages correspond so nearly to the primitive method that a cursory examination of its technique may be of value.

The actual machine is very complicated and divided into numerous parts, but as this description is merely to show the principle, only two parts will be considered, the creel which holds the bobbins of roving and the head which contains the spindles of completed yarn.

The roving passes from the creel through a set of drawing rollers and is attached to the spindles. The head then moves away from the creel while

at the same time the rollers deliver the roving. As the head moves, the spindles revolve rapidly. Draft is created by the drawing rollers and the moving head and the rapidly revolving spindles insert the twist. The head travels in all about sixty inches, and when about fifty-four inches have been covered, the rollers cease to deliver roving and the head moves the last six inches without additional roving. At the same time the number of revolutions of the spindle increases. This last stage is very important. It stretches the roving into even yarn and allows the final degree of twist to be inserted. The head then travels back to the creel and the spindles wind up the completed yarn.

From the brief description above it will be seen that spinning is divided into three stages: 1. The cleaning of the fiber; ginning to remove seeds; picking or scutching to disentangle fibers and remove large impurities; carding to remove fine dirt, broken fiber, etc., and to place the fibers practically parallel to each other. 2. Attenuation of card sliver, or draft by the draw frames. 3. The gradual decrease of draft and the gradual increase of twist in fly frames, and the spinning mule.

The processes prior to spinning with the old spinning wheel were, of course, much simpler than those described above. The cotton seeds were removed by hand and the wool washed to remove grease and dirt. The fibers were then beaten with little switches to open them up and were finally drawn over a comb in order to lay them approximately parallel to each other. Using modern terms, they were ginned or scoured, scutched and carded.

Next the carded fibers were rolled into short soft boluses. These would correspond roughly to draw slivers. From the ends of these boluses a few fibers were withdrawn and twisted into a soft, rather thick filament, resembling a modern roving. When the wheel was used this roving was attached to the bobbin and over the lower hook of the flyer. Next, the bobbin was caused to revolve by pushing down with the foot the treadle attached to the large driving wheel. Both hands were constantly engaged in the withdrawal of fiber and the continuous formation of roving which the bobbin and flyer twisted into thread.

A still more primitive method of spinning that was practically universal was known as the whorl and distaff method. Here the prepared fiber was held in some convenient position and a roving formed as above. The spindle was a stick of wood or metal about twelve inches in length, near the lower end of which was a circular weight of which the spindle formed the axis. The roving was attached to the top of this spindle which was caused to spin by a sharp twist of the thumb and finger and released. The roving was gradually paid out as the revolving spindle descended. The weight and the spindle inserted the necessary draft and twist.

Still another form of spinning, rarer than the above, was performed by causing the whorled spindle to revolve in some smooth receptacle and skilfully feeding it roving to be twisted into thread. Spinning was also carried out, in a way, by rolling fibers on the naked thigh.

The power loom of today is simply the Asiatic foot treadle loom to which power has been applied. Its principal difference from the earlier hand looms lay in the manner in which the warps were separated in what are termed sheds, for the insertion of weft. These sheds were formed by means of heddles connected with the treadle operated by foot power. The heddles were wooden frames with holes or loops in them for the yarn. At least two such heddles were required to make plain cloth. Through one of these heddles the even numbered warps were drawn, through the second the odd. They were attached to the treadle in such a way that when one treadle was pushed down, it lifted one heddle and consequently every other warp. The triangular space so produced is called a shed in weaving and is the space between the divided warps through which the shuttle containing the weft thread is inserted or thrown. The weft bobbin is placed inside of a smooth hollow wooden receptacle called a shuttle. The yarn is drawn out through a hole in the side, fastened to the first warp on the near side of the loom and thrown or slid through this space or shed from hand to hand. The reed is a solid frame containing fine wire or split reed (hence the name). This is placed over the warps in such a manner as to allow them to be divided in convenient equal groups between the splits. After each pick of weft is inserted this reed is drawn sharply forward and drives the weft yarn up to form a compact fabric.

By using a number of heddles and thereby being able to lift warps in almost any preconceived order, it is possible to produce a great number of pleasing designs. What the reader should bear in mind is that the design is here produced by *warp* manipulation alone. Weft must always travel, as the shuttle delivers it, straight through whatever shed the heddles form. This is the fundamental of modern fancy weaving, the highest mechanical expression of which is the Jacquard loom.

Yet, the still earlier form of loom to be described in this paper is the same as used today for the production of textiles that have an art value, such as Oriental rugs and true tapestry. Here the feet are not employed and the shedding devices are most rudimentary. The thrown shuttle is unknown; weft is carried on an uncovered bobbin and passed from hand to hand through the shed. Here design is produced almost entirely by *weft* manipulation, is in fact, a kind of darning, and the entire operation is under much greater control by the artist.

The primitive type of loom just described embodies all the essential

weaving processes and every mechanical addition to this primitive loom has been for the purpose of increasing production. Aside from this, nothing has been added to the loom. When textiles became a necessity and ceased to be wholly insignia of rank or savage ornamentation, the demands exceeded the scanty yardage possible by this tedious method and gradually, through an evolution not too difficult to trace, the fertile ingenuity of the human mind produced the mechanical marvels of the modern mill. But the complete philosophy of the craft had been worked out long before such economic pressure made itself felt, and this paper deals with the examination of a most extraordinary textile development of a prehistoric people preserved in a surprisingly complete condition by the sandy deserts of Peru.

THE FIBER.

Three of the four great classes of textile fibers are found in Peru: cotton, wool, and a bast fiber (probably maguey). Only silk is absent.

There are two kinds of cotton, the white and the reddish brown variety. The latter is claimed by some authorities to be a sport of the former and not a separate species, its reddish color being an indication of a reversion to a wild type. The seeds of both are smooth, but in regard to lint, they are quite distinct. The white is very pure in color, perhaps one quarter longer on an average, very much evener in diameter, and contains a greater number of convolutions per inch than the brown. The photomicrographs [1] show this very clearly (Figs. 2 and 3). The white averages from 1 to $1\frac{3}{4}$ inches in length, the brown perhaps $\frac{1}{2}$ an inch less.

The average length of wool fibers is as follows: vicuña from $1\frac{3}{4}$ to $2\frac{1}{2}$ inches; alpaca from three to five inches; llama from five to seven inches depending on what portion of the fleece they had been taken from. The human hair used was black and rather coarse, but very long.

The wools are by no means as good for spinning purposes as the camels' and goats' wool of Asia. Seldom could they get staple in a white natural shade for dyeing. However, the vicuña has a beautiful natural luster that caused the old Spanish writers to compare it with silk, both for sheen and feel.

Very little can be learned as to the preparation of wool fibers for spin-

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[1] Sixteen samples were examined by Mr. K. B. Lamb, six of which we have taken as typical.

Fig. 1 is a sample of very fine 1 ply yarn. The magnification of this photograph is seventy-five times. This is a most remarkable piece of work. The twist figures out about 225 times to the inch and is higher than we have ever found in modern yarns. The fineness and closeness of the yarn is remarkable.

Fig. 2 is a sample of white cotton. The photo shows the cotton fiber magnified 150 times. The appearance is fair but the fibers are not as uniform nor have they been as well ripened as our modern cottons.

Fig. 3 is a sample of dark brown cotton magnified 150 times. The same may be said of this sample as of Fig. 2. In addition, the fibers are slightly coarser than our modern cottons.

Fig. 4 is a bast fiber from cloth magnified seventy-five times.

Fig. 5 is a sample of wool, vicuña. This shows the wool fibers magnified 150 times. Their appearance would seem to indicate that the fibers had good spinning and felting properties.

Fig. 6 is a sample of woolen yarn, two-ply, magnified seventy-five times. This sample shows twenty-five turns per inch and a very even twist.

The photomicrographs were made with a Bausch and Lomb photomicrographic camera using a Bausch and Lomb microscope and an artificial light (arc light). Two magnifications were used depending on the nature of the sample, i. e., 75 diameters and 150 diameters.

ning. They are found in the baskets, in grease and tangled, and in a cleaned and carded condition. Perhaps the only processes were thorough washing in water for removal of animal fats and a gentle pulling apart as in cotton, to straighten out the fibers. The wool used in the best Oriental rugs receives little more preparation, but after being washed it is packed with meal to absorb any surplus grease. This may have been the practice in Peru, but there is no evidence to prove it.

When the cleaning and carding were finished, the fiber was drawn through a slit on the top of a short stick (Fig. 7). A ribbon attached to this stick allowed the spinner to fasten it in a convenient manner. This distaff resembles those used in Europe before the introduction of the spinning wheel. In Peruvian spinning it serves the same purpose as the cotton cone — presents the fiber in a carded condition to the spinner.

The human hair was used to form braids, sometimes to form very open meshed fabrics, and very often when black was used in the design. It probably had little preparation except washing for the removal of grease.

The bast fiber of Peru is a kind of hemp, the *Agave americana,* or maguey, derived from the cactus leaf.[1] It appears most frequently in twines, in certain nets, and in lace bags of considerable fineness. However, certain fabrics resembling the mummy cloths of Egypt are made from this fiber. Of its preparation little is known. The nature of this class of fiber requires that the leaf from which it is derived be broken up in some manner into fiber of a greater or lesser degree of fineness. This process is known as heckling. Bundles of the fiber previously immersed in water or dew until the pith and outside matter have been removed, in other words retting, are drawn over a number of sharp points and thus split. No such device appears among the implements used in Peru. There is, however, an interesting bundle of maguey fibers, the untied end of which plainly shows some kind of heckling (Fig. 8). Such fibers are prepared by the natives in Mexico today by first allowing the leaves to ret in the dew and then scraping off the fatty matter. The individual fibers are then obtained by pounding or rolling between stones. This seems reasonable enough for the coarse fiber of the twines, but leaves some doubt as to a similar method for the delicate fibers of the lace bags and the fine cloths since these fibers show a degree of fineness almost incredible in bast of this class.

It cannot be said that the spinners of Peru were particularly fortunate in their staples. The fine cotton of ancient India, the camel and goat wool of Persia, and the true flax of Egypt were certainly superior in spinning

[1] "Those Provinces were most charged with the Assesment for Shoeing where Hemp grew in most plenty, and was made from the Stalk of a Plant called *Maguey.*" Garcilasso de la Vega, Book V, Chapt. VI.

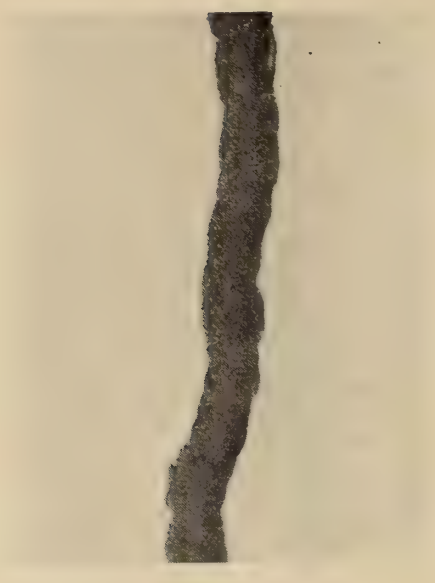

Fig. 1.

Fig. 2.

Fig. 3.

Fig. 4.

PHOTOMICROGRAPHS OF COTTON AND BAST FIBRES.

Fig. 1. Finest Yarn of Brown Cotton, 75 diameters.
Fig. 2. White Cotton Fiber, 150 diameters.
Fig. 3. Brown Cotton, 150 diameters.
Fig. 4. Bast Fiber, 75 diameters.

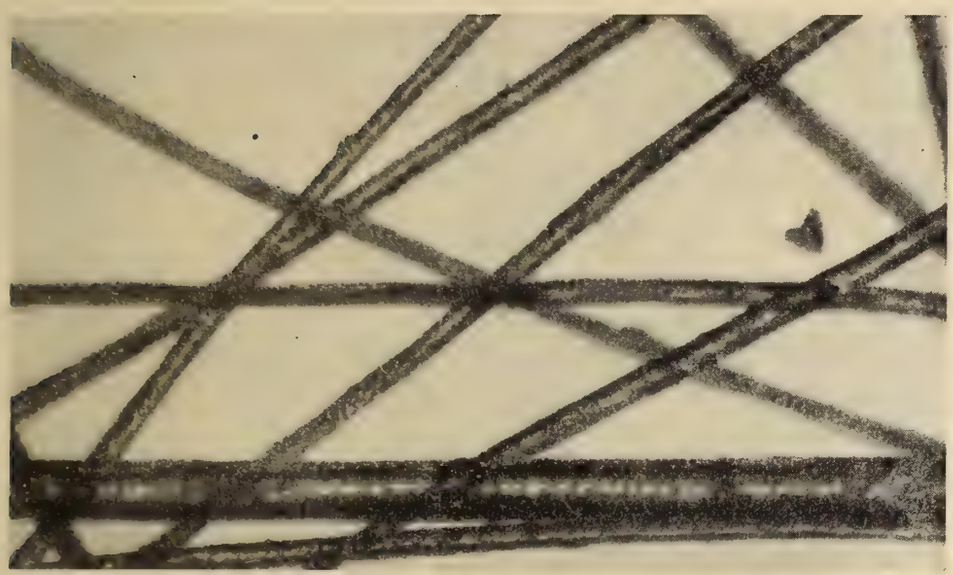

Fig. 5. Vicuña Wool, magnified 150 times.

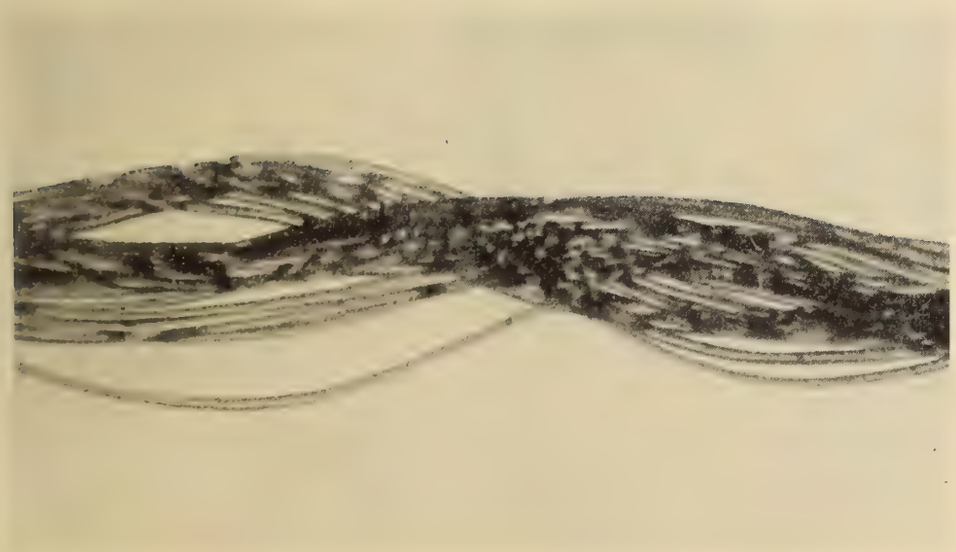

Fig. 6. Finest Two-ply Vicuña Yarn, magnified 75 times.

Fig. 7 (B–7768). Wool Distaff. Length, 31.5 cm.

qualities. The same fibers exist, with little change, in modern Peru but in no case, with the possible rare exception of vicuña, are they used in the making of really fine textiles.

Both the cottons are very wiry, and considered by modern standards, of inferior spinning qualities. At the same time, they show certain characteristics of cotton grown by irrigation, such as the comparative freedom from dead and immature fiber. The cotton examined from Nasca was rather inferior to that from Pachacamac. Perhaps this may have been due to irregularity in the water supply of the Nasca Valley.

The white variety is very much better than the brown. However, in the finer fabrics of Peru, the brown is more generally used, perhaps from some superstitious reason or because the color was more desirable. Brown cotton is referred to in the literature of the subject as having been saved for the rulers. If they had a preference for this color, such as we entertain for white, its appearance in yarns of great fineness is comprehensible, because,

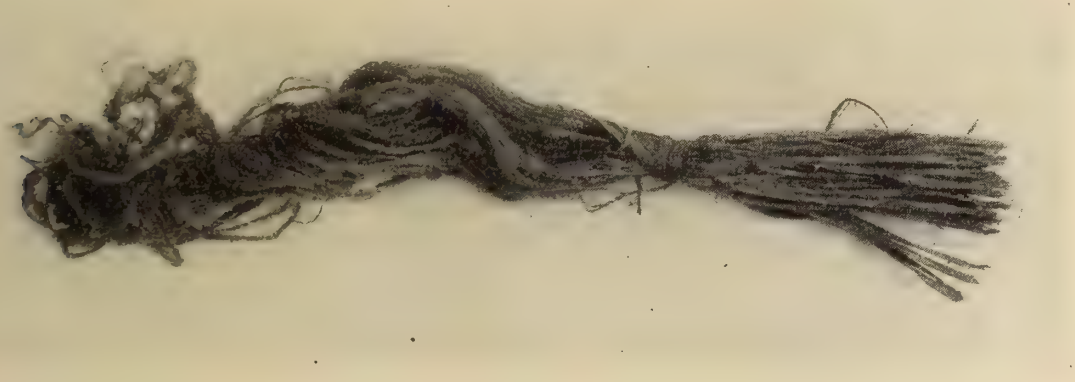

Fig. 8 (B-3472). Bundle of partially heckled Maguey Fiber. Length, 49 cm.

great dyers, though they were, this one color seems to have bothered them. Of all the shades, it is the only one which is not up to the high standard they set for fastness.

As we have noted, between ripe cotton fiber and yarn there are at least three indispensable operations: the removal of the seeds, the separation of the individual fibers, and the laying of the fibers in the same general direction, that is, ginning, scutching, and carding. It was the custom, according to Garcilasso de la Vega, for visiting ladies to ask for cotton in the boll, and while carrying on a conversation to remove the seeds by hand; but of the other equally important though perhaps less obvious tasks nothing is mentioned, except that they were by hand.[1]

[1] "They combed cotton and fine wool with their fingers, for want of cards wherewith to card it." Book IX, Chapt. XXX. Garcilasso de la Vega.

So direct information having failed us, let us see if we cannot reconstruct the processes. Cotton is found in the work baskets from Peruvian graves, in the boll, scutched, and felted into a ribbon and in a cone-shaped bundle, resembling a miniature beehive (Fig. 9). The peculiar feature of this cone is that fibers withdrawn from the large open end are parallel, that is carded and quite ready for spinning. Just how these cones were made was not quite clear until a number of soft thick ribbons of cotton were found (Fig. 9d). Upon investigation, the fiber in them was discovered to be in a carded condition. This ribbon was broken up into proper lengths and from these the cone was formed. From the collection, it appears to have been the custom to save the small tightly bound points of the cones. This may have arisen because, owing to their compactness, it was difficult to draw fibers from them for spinning as the binding thread is much tighter and more closely wrapped at the apex.

From the data at hand we infer that the processes were as follows: The seeds were first removed by hand. The fibers were next separated from their tangled condition. Little tufts were then gently pulled apart between the two hands. They were held just firmly enough to cause the fibers to separate but not break, just as a cotton tester pulls apart again and again a sample of staple when determining the length of the fiber. As each little tuft was thus carded it was felted into the ribbon above described. No tools that could be connected with these processes have been found, not even small bundles of switches for scutching. All we know is that it is referred to in the literature of the time as the labor of the lower classes; yet the fiber in our collections is remarkably clean and well carded.

The animal fibers are vicuña, alpaca, llama wool, and human hair. These first three resemble camel's hair. These animals belong to the camel family. The wool scales are very fine, almost imperceptible even under a microscope. They range from the fine soft vicuña, alpaca next, to the rather coarse llama wool. Different parts of the fleece yield different grades of staple; the finest alpaca is better than a coarse vicuña and finest llama better than alpaca. But grade for grade they range for fineness as follows: vicuña, alpaca, llama.

Owing to scarcity, perhaps as much as poor spinning qualities, they are little used by the trade today. The name, vigogne, French for vicuña, is applied to a rough yarn made from cotton, short staple wool, and silk noil or sometimes shoddy and cotton. The name alpaca is applied today to a fabric woven from goat hair weft and cotton warp. The actual fibers are still used in native weaving of ponchos, suggesting in technique, the ancient masterpieces.

SPINNING.

The natives of modern Peru spin with the whorl and distaff method described in the Introduction. Among the archaeological relics from other parts of South America whorls of stone and pottery are quite common, but in Peru they are very rare, although spindles evidently made on a different principle are among the commonest relics of this interesting country.

There is some record by the Spanish historians of sticking a lemon or small potato on the end of the spindle to take the place of the whorl, but

Fig. 9. Stages in the Preparation of Cotton Fiber as found in Peruvian Work Baskets. In logical order they are: 1(c, B–8746), Bolls of white and brown cotton; 2 (b, B–8746), Seeds of white and brown cotton with lint attached; 3 (a, B–8746), White and brown cotton in scutched condition; 4 (d, 8742), Ribbon of carded cotton; 5 (e, B–834), Cotton cone.

this seems a rather unlikely makeshift for a people who had such a penchant for tastefully painting their spindles and carving their spindle bands. The few true whorls found may have been intrusive in ancient times or belonged to a much later period. Almost every woman must have been a spinner and if whorls were used they should be very plentiful in our collections. Gar-

Fig. 10 (B–8405). A Vase from Pachacamac, Peru. Height, 20 cm.

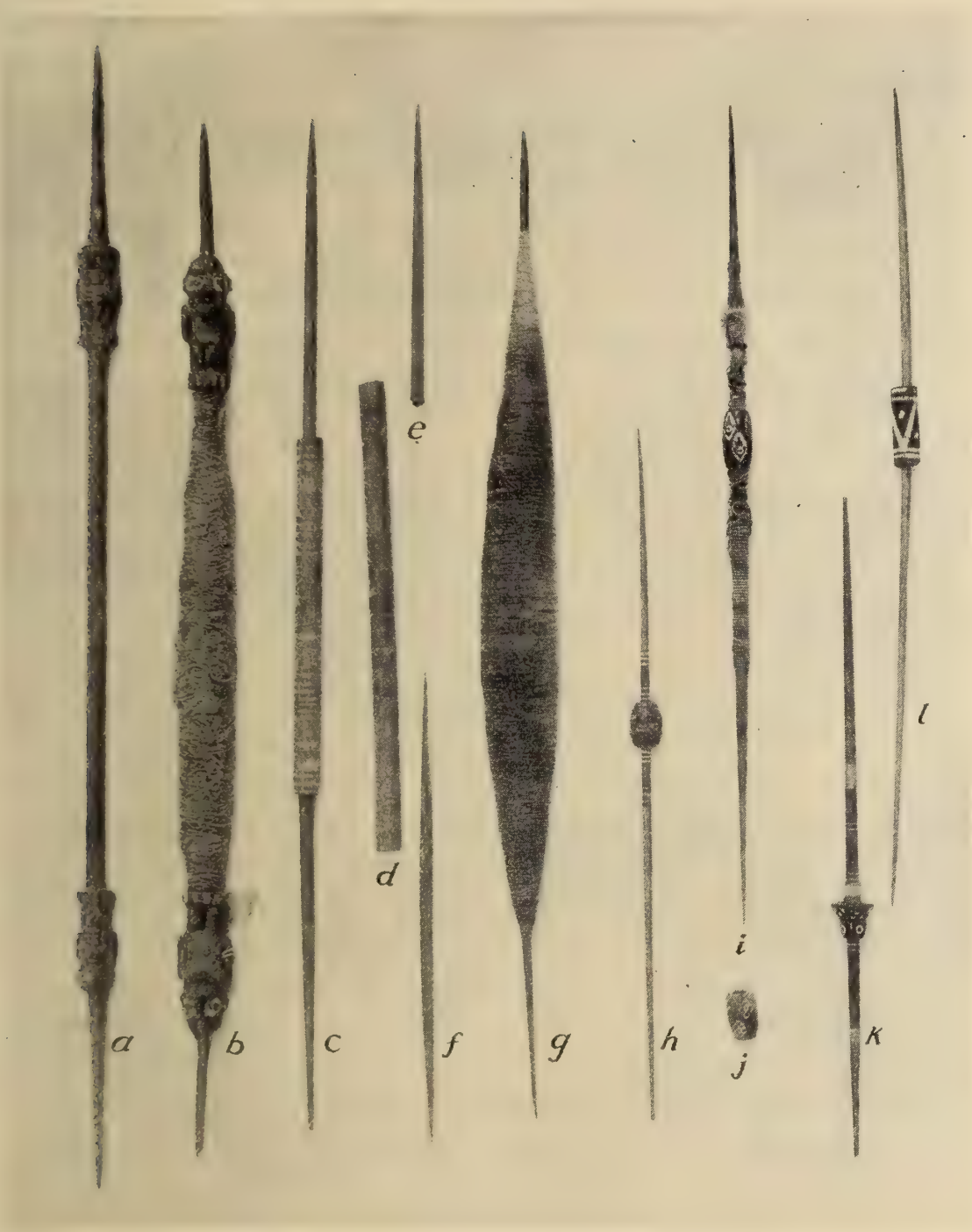

Fig. 11. Types of Peruvian Spindles. *a* (B–8123) Doubler spindle, empty; *b* (B–8132) Doubler spindle containing yarn; *c* (B–8742) Tri-part spindle, empty; *d*, *e*, *f* (B–8749) Parts of tri-part spindle; *g* (B–712) Tri-part spindle containing yarn; *h*, *i*, *k*, *l* (B–8745, 8747, 8745, 8742) Different types of banded spindles; *j* (B–8741) Pottery band removed from spindle. Length of *a*, 42 cm.

cilasso speaks of the women walking about doubling and twisting two yarns together but makes no reference to ambulatory spinning. Now, where the whorl and distaff method of spinning is used women spin while engaged in any occupation that leaves their hands disengaged occasionally. So, on the whole, we have strong negative evidence against the use of the whorl and distaff method in ancient Peru.

A famous picture vase, depicting the act of spinning is positive evidence (Fig. 10). The absence of the indispensable whorl almost precludes the possibility of this representing the distaff and whorl method. Besides, both hands were necessary to the formation of the roving, and on the vase, the woman holds a cone of cotton in one hand, the point of the spindle in the other, while a white line between the two represents the yarn. Now, it seems reasonable to assume that if the spindle were to be spun and dropped, that in the first place it would contain a whorl and in the second, the spinner would hold the roving, not the cone. I therefore make so bold as to suggest that this vase really represents the act of winding up a completed length of yarn already spun in some other manner.

Perhaps the distaff and whorl, so general in other parts of South America may have been used to some extent in Peru. Possibly the small number of whorls found may indicate its earliest introduction. Some of the coarser yarns may have been spun in this manner, but the fact remains that the commonest forms of spindle and certainly the ones used in making the finer yarns were of such a nature as to preclude their employment in this form of spinning. One last fact in this connection. The usual shape of the cop of yarn formed by the whorled spindle is a cone, its base resting on the flat upper surface of the whorl. Now the cops of yarn on all the Peruvian spindles taper gradually from the center to the points (Fig. 11g). It is difficult to see how this shape could be made if the whorl were used.

The two distinct types of Peruvian spindles owe their difference to the width of the web they are subsequently to be used in as wefting implements, for it must be borne in mind that these spindles have dual functions, one as an aid in spinning, and the other as a bobbin to contain the weft passed between the warps.

The commonest form is a single stick of palm wood, highly polished, pointed at both ends, and having an ornamented pottery (sometimes hollow cane or copper) band in the center (Fig. 11h, i, k, l). The lengths and diameters of these spindles vary from the size of a large darning needle to ten or twelve inches in length and perhaps quarter of an inch in diameter. As a general rule the more delicate the spindle, the finer the yarn. If the weight of the pottery bands (Fig. 11j) did not preclude their use as whorls their position on the spindle would. This position is thoroughly established by the

size of the holes and the fact that most spindles are decorated with rings of paint to indicate the position of the band. The function of this band was far from being purely ornamental. It prevented the cop of yarn from slipping off the spindle when it was being used in weaving and at the same time being covered with yarn offered no resistance to the tightly stretched warps. For the sake of clearness, I shall refer to this type as the banded spindle. Certain spindles belonging in this class have a short section of hollow cane in place of the pottery band, but the spindle is one piece of wood. (Fig. 11 l.)

The second type is in three parts. (Figs. 11c, d, e, f.) Two pieces of polished and pointed palm are stuck in the ends of a piece of hollow cane. The idea, apparently, was to make a weaving bobbin of greater length. It must be borne in mind that the bobbin is passed from hand to hand through the warp sheds, not thrown as is a shuttle, and greater length would be a distinct

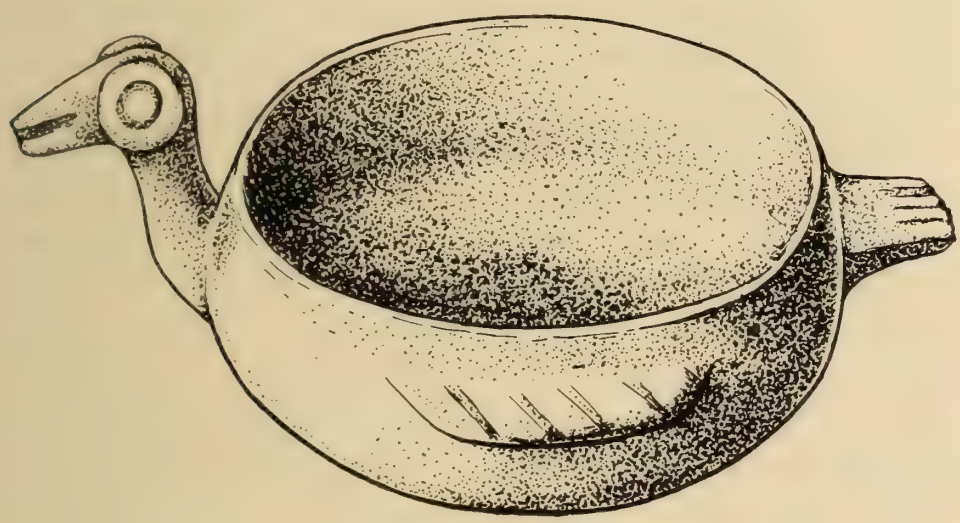

Fig. 12 (B–8743). Spinning Bowl.

advantage when weaving wide fabrics. Perhaps it was difficult to make a bobbin of sufficient length or it may be such long pieces would have a tendency to warp out of shape. Whatever the cause may have been the use of these bobbins is quite obvious. To distinguish them I have termed them tri-part spindles.

A large number of pottery bowls, resembling in size and shape deep saucers are found in the work baskets. (Fig. 12.) It is extremely probable that these were used as rests for the points of spindles. Among savage people today sea shells and cocoanut shells are often used for the same purpose. The ends of Peruvian spindles show great smoothness, the natural result of such friction. It is well known that damp fiber spins to better advantage than dry and perhaps some of these bowls may have contained water to moisten the spinner's fingers.

From these facts we shall try to reconstruct the actual mechanical movements of this wonderful spinning. It can be nothing but the barest outline, as the little tricks, and craft secrets of so old an art, must defy all analysis. The spinner placed the mass of fiber to be spun in some convenient position, perhaps stuck in the belt, or under the arm. From this the proper number of fibers was withdrawn, forming what may be styled a drawing. A slight amount of twist was next inserted, corresponding to a roving. This was twisted about the center of the spindle. Certain partially empty spindles in the collection contain short fragments of this process. Then more fiber was withdrawn, twisted, and attenuated. The point of the spindle was placed in a pottery bowl, the other tilted away from the direction from which the yarn was being formed. The spinner then gradually, with thumb and finger, inserted the desired amount of twist. Little imperfections, nebs, and foreign matter were next removed by gently rubbing with thumb and finger.[1] Perhaps the final twist was inserted as the yarn was being wound on the spindle. Thus the function of the spindle was little more than that of a container for yarns already spun.

To recapitulate, the only implements for spinning (barring the doubtful use of the whorls) were the cotton cone and wool distaff containing carded fiber, the two forms of spindle, and the pottery bowls. This reconstructed process above ascribes uses to each of these, and also accounts for the essentials of spinning, i. e., draft and twist.

Almost all Peruvian yarns are two or more ply. (I found but once a wool yarn, single-ply.) The object of doubling and twisting is to obtain greater evenness and more uniform strength. In the best of spinning, irregular size and strength must appear in single yarn. If two or more singles are combined it is very unlikely that this unevenness of diameter and strength should appear in the same spot in the several yarns, for which reason it is better to have double and twisted yarns than single-ply yarn of corresponding count.

The implement used for this purpose is a piece of hardwood, longer and thicker than the ordinary spindles. There is no pottery band to prevent the yarn from slipping, but at either end about $1\frac{1}{2}$ inches from the point are raised carvings (Fig. 11 a, b). It appears that the yarns from two spindles were wound on these doublers. The spinners then drew them out and twisted them together. The last few inches on some specimens still plainly

[1] "Their spindles were made of canes as we in Spain have them of Iron, they were crooked, but not hollow at the point as ours are: with their thread they made a kind of Filleting, which they wound in upon their spindles, twisting it with the fingers of their left hand: their Distaff they carried in their left hand, and not at their girdle; being about a quarter of a yard long, and held between two of their fingers, and then with both hands they formed the fineness of their thread, and cleared it of foulness." Book IV, Chap. XIII. Garcilasso de la Vega.

show this process. None of these doublers have more than two yarns on them, and yet many cotton tapestry warps are either three or four-ply, and at least one, seven-ply. Perhaps the product of two doublers for four-ply or a doubler and a spindle containing single-ply for three-ply may have been combined. One rather confusing circumstance is that no doublers containing warps have been found. Peruvian warps show a very high knowledge of spinning, great evenness of diameter and regularity of twist, but even in the face of not finding them made in this manner, there are no other tools which could have made them, and therefore they must be the product of the doubler.

To sum the matter up, the spinning tools were the banded and tri-part spindles, and the doubler-spindle, the cotton cone and wool distaff and whatever form of distaff maguey and human hair may have been used in, and the spinner's bowl. Yet that no other tools than these primitive implements, were employed in making such wonderful yarns seems incredible. The yarns are the best ever produced. Almost every degree of twist appears, the purpose of the yarn being taken into careful consideration. No machine yarns, however excellent can approach their perfection.

YARNS.

The basis of all good weaving is good spinning and the excellence of yarn is a truer guide to textile development than is the woven fabric, for in the latter, the design plays an important part, and this is governed solely by location and national taste. The use to which a fabric is to be put may be so widely different either in point of years or geography that a proper estimate of its merit may be difficult to appraise, but yarn is a fixed quantity; every class of weave, lace or embroidery, requires certain well understood qualities, and in a measure, we may say, that there is a fixed, standard towards which all spinning tends.

William S. Murphy in his "Textile Industries" speaks in the highest terms of Peruvian yarns. No words of the writer could equal in praise the opinion of this distinguished authority. The exact reference is here given:—

> It may be that the makers of Cashmere shawls, Dacca muslins, Aztec veils, and Peruvian robes inherited the long labours of a thousand generations; but so far as the spinners of what we call modern civilization are concerned the ideal has been realized, and belongs rather to the past than to the present or the immediate future. The perfect thread is not to seek; it has been made.[1]

[1] William S. Murphy, vol. 3, 83.

The modern method for determining the fineness or size of yarns, is to ascertain how many yards of any given kind are contained in a pound. The ordinary way is to weigh a certain unit of length which is known as a hank, and then determine how many hanks are contained in a pound. The number of hanks in a pound is the count of yarn. The number of yards in the yarn hank varies with the nature of the fiber. For example, the linen hank contains 320 yards; the worsted 560; and the cotton and silk, 840 yards. These arbitrary divisions date back to the days of hand spinning and lack scientific clarity inasmuch as they consider only two qualities — length and weight. The diameter of the yarns is not considered. Obviously, it was impossible to obtain such great lengths of Peruvian yarns as are necessary to make the modern weight tests. Shorter lengths would reduce accuracy. Therefore, the only way to determine size or count of the yarns was by comparison with modern yarns of known count and the approximate counts given therefore, apply solely to diameter. In the interest of clearness, a single standard was chosen, all yarns whether cotton, wool, or maguey were compared with modern cotton yarns, the hank containing 840 yards. Such a gauge is at best guesswork, but repeated comparisons under magnification and the consensus of opinion of many yarn experts, better qualified to judge than the writer, made these tests fairly accurate.

It will be recalled that three of the four great classes of fiber were spun. It will be shown later that almost every class of woven fabric had its representative in Peru. The difference of fiber spun and the varying weaving requirements of the yarns were carefully considered: strength, covering qualities, rigidity, evenness, elasticity, according to the ultimate purpose of the yarn, were fully allowed for by the spinner. In short, after a very careful search no incident of the improper use of yarns was discovered in the Museum's collection. To be fair, the spinning is not only in advance of the best machine spinning but apparently contains the application of certain principles that are unknown today. This applies more particularly to their finest work. The yarns in their commoner and coarser fabrics are not as even as our cheaper yarns today, but I hazard a guess, were much stronger in proportion to diameter.

Peruvian wool yarns are almost invariably two-ply. Of course, they were spun singly. In only one fabric — a light veil — were single-ply wool yarns woven. Owing to the superior dyeing qualities of wool, these yarns were generally used as the decorative element. All the finer tapestries and bobbin-weaves contain two-ply wool weft. Trifling exceptions to this are the occasional use of white cotton, where white is required, and human hair where black appears. The alpaca, llama, and human hair are occasionally employed as warps.

The best illustration of the knowledge of the craft to which these old spinners attained is to be found in their matchless tapestries. Here the weft must be exquisitely fine so as to allow for a great number to be inserted in an inch, and at the same time possess great covering quality so as to leave no bare spots on the warp. A certain degree of elasticity is requisite to allow for a very severe beating up in the weaving. But the acid test for the spinner is the tapestry warp. Here is required a yarn as nearly cylindrical and smooth as possible, very even in diameter and possessing great strength and rigidity, for the weft must meet with no roughness during the beating up. There must be no sagging in the warp, nor great difference due to inequality in the size of the warps in the repp effect that is characteristic of tapestry.

The finest Peruvian tapestry warps are of cotton. Three and four-ply cotton was used. But the three-ply has certain advantages of smoothness over the four. In some cases the yarn is formed from two slack twist yarns, twisted tightly with a third of tighter twist. An example of the finest cotton warp (B-1225) is on exhibition in the Museum collection. It forms the warp in the finest piece of tapestry the writer has ever seen; from a technical standpoint perhaps the finest ever woven. It is unique among Peruvian fabrics in having a true selvage in the modern sense, that is, a selvage running parallel to the warps. This was formed by inserting four seven-ply warp ends at the edge. Surely, this is an unusual thing for a primitive weaver to do.

The warp and weft of bobbin-weaves have about the same characteristics as in tapestry, but in double warp fabrics a new condition is faced; here, both warp and weft appear equally in design and therefore must have the same degree of twist, while in pile knot and in embroidery a much slacker twist is employed. A large number of light weight fabrics have a certain crêpe-like appearance due to the intentional insertion of a great degree of twist in the yarns that produced a very attractive crinkle in the fabric. Voile fabrics very open in appearance were made from yarns containing a truly amazing number of turns or twists per inch. These yarns do not crêpe, as above, but have bite enough to prevent the fabric from slipping. A yarn from the finest example of this class of weaving has been photographed by Mr. Lamb through a microscope and is the basis of a very remarkable calculation in his report. (Fig. 1.)

Ply yarns from singles of different colors, were twisted in what is known today as contrast twist. Tinsel yarns of silver have been spun in Peru by twisting a thin band, or ribbon, of silver about a finished yarn. It is a principle of doubling yarns, that the softer yarn will cover. In this case the silver ribbon was the softer and it seems certain that originally

the silver covered the entire yarn, but wear and the expansion of the yarn due to moisture has given it, at present, a banded appearance.

The maguey yarns are so rare that anything approaching a generalization on them would be very rash. Only two examples of this kind of fabric are in the Museum's otherwise ample collection. However, there is a large amount of twine spun from this kind of fiber and one interesting fragment of tapestry has maguey warps.[1] The great length and individual strength of this bast fiber made the very tight twist so remarkable in the cotton and wool yarns, undesirable in maguey. The evident knowledge of this fact coupled with the great excellence of the few samples examined lead to the conclusion that the weaving of this kind of fabric was much commoner than the paucity of the specimens might otherwise indicate.

Mr. M. C. Andrews of the Ardoyne Works, Belfast, Ireland, a prominent manufacturer of linens, examined a small sample of the two maguey fabrics and pronounced them excellent both in regard to fiber and yarn.

We will now consider the fineness of these yarns in connection with their diameters. In so doing it may be well to call attention to the fact, quite obvious to anyone having textile experience, that the count of yarn possible to be spun depends largely on the nature of the fiber used, and what in one grade of staple, might be excellent spinning, in a finer grade would be very ordinary, and vice versa. It is to be regretted, that so little information is obtainable as to the modern use of the great wool staples of Peru, llama, alpaca, and vicuña, but the general opinion is, that, along with South American sheep wools, they possess rather inferior spinning qualities. To the eye the soft lustrous vicuña appears to be a most beautiful staple, but under the microscope it shows much fewer scales than a corresponding grade of camel's wool, and on the friction producing quality of these depends the spinning qualities of wool.

The Peruvian cotton of today is perhaps a little better than the old grade, owing to the crossing in of the Barbardense, or Sea Island strain. But both are greatly inferior to the wonderful silky fiber of the modern Sea Island cotton. The marvelous Daccan muslins of ancient India, have always stood as the acme of ethereal lightness among woven fabrics. Here too, the fiber played a vital part, for it has been discovered that a certain stretch of rich valley in the Punjab produced, in ancient times, a cotton little if any inferior to the finest of our modern cottons. The spinners of Dacca strove for great lightness, which does not appear to be the case in ancient Peru. From the best evidence at the writer's command the finest Daccan yarn was about No. 500 or 500 by 840 yards per pound, or 420,000 yards.

[1] A number of handsome lace bags were knit from maguey thread.

In Manchester, England, a few pounds of No. 420 are spun today from cotton one third less in diameter than the Peruvian staple, at least twice as long and containing from one third to one half more of the indispensable convolutions per inch. From the Peruvian cotton the best modern spinning ranges from No. 50 to No. 70. The writer has examined ancient Peruvian single ply cotton yarns as fine as No. 250, many as fine as No. 200 and 150 and three and four-ply yarns from 120 to 130.

If some consideration must be allowed Peru in the comparison in regard to the cotton yarns because of fiber, no such leniency is necessary when we come to the consideration of wool or rather worsted yarns. For almost all Peruvian yarns from this fiber appear to have been combed. The finest modern worsted yarn at all common is about No. 120 in the worsted scale of 560 yards to the hank or approximately No. 80 in the cotton scale of 840 yards per hank. Perhaps some finer worsted yarns are made, but very few, and certainly none in this country. Now, while the nature of fiber, improved method of cleaning and combing, dampening, etc., are advantages in favor of the modern spinner, the ancient Peruvian craftsman, produced yarns of worsted about three times as fine.. Many woven fabrics contain yarns as fine as 130 to 170 two-ply and one fragment of undyed yarn is between No. 180 and 200 two-ply in cotton count, or about 300 worsted count! While little remains of this spinning masterpiece, yet there is quite enough to prove it was not an accident. And the wonder how such yarns could be produced with their simple tools has never left the writer during the entire investigation.

The finest maguey yarns are about the same as a modern 36 two-ply cotton. Considering the fiber this is remarkably fine.

The ways in which yarns are put up are very important as indications of their use. The different forms in which yarn occurs in the Museum's collection and their different functions are as follows —

1. Balls about the size of an orange. These are very closely wound about some object, sometimes a corncob. The degree of twist in these yarns indicates that they are warps. Aside from a possible use as a reserve supply or a convenient form for storage, I can assign no use for them in weaving. It is generally supposed they were used as a form of currency.

2. Small skeins for dyeing. Sometimes these were loosely knotted to prevent tangles in the dye pot. Other small skeins of decorative weft, the unused fragments from woven figures, could be used in small tapestry and embroidery figures when only short lengths of yarn were required.

3. Weft yarns, wound on banded spindles, tri-part spindles, and bobbins, ready for weaving and a number of short pieces of cane, wrapped with a reserve supply of yarns for the spindles and bobbins.

4. Warp chains, consisting of a number of skeins of the same length and each as long as the fabric into which they were to be woven. This was an important discovery as indicating the method employed to avoid a fatal tangle in the warps when placing them on the loom. With the exception of certain narrow ribbons, the entire length of warp was stretched on the loom at one time and previous to the introduction of the warp beam, the use of a chain of skeins containing the same approximate number of threads, and exactly the same length was a most ingenious method of handling warps.

Fineness of diameter alone, while an indication, is by no means an infallible proof of the best spinning. Evenness in size and strength and a proper consideration for the intended purpose are much better guides. The degree to which these were carried in Peru beggars description. It is no exaggeration to refer to them as perfection. From a technical standpoint it may be said that the single yarns show a much higher degree of twist, and the ply yarns rather more turns per inch than our modern yarns. They are much more cylindrical in form, contain a larger amount of fiber in proportion to their diameter, and were much stronger.

Space does not permit of a more exact treatment of this interesting subject. Specimens of cotton, maguey, and wool, and human hair yarns have been prepared and are on exhibition in the Museum with specimens of the different types of woven fabrics. An examination of them will amply prove the accuracy of the above statements.

Another important subject for investigation is dyeing. The writer is not competent to go into the details of this problem, but submitted samples of these yarns to Mr. K. C. Lamb of the United States Conditioning and Testing Company, from whose report we quote as follows:—

> As far as can be determined, considering the great age of the samples and the chemical changes which may have taken place during this time, all the fabrics are dyed directly without the use of a mordant. It is possible that in some of the yellows and greens a vegetable mordant such as some tannic material has been used, but tests fail to confirm this.
>
> The blues are very fast and the best of all the colors examined. They are probably indigo shades oxidized on the fiber, this being the reason for their fastness. The browns are poor in fastness and cannot compare with the other colors.
>
> The tests were made for fastness to boiling water, boiling solution of neutral olive oil soap, acids (hydrochloric, acetic) and alkalis, (caustic soda, ammonia). The fact that the dyes have kept their brilliancy and body for three or four thousand years is a good proof of their fastness to air, light, dust, and general atmospheric conditions.

WEAVING AND WEAVING IMPLEMENTS.

What are commonly known as hand looms, really might better be called foot looms, since the feet are used to perform very important movements. Aside from the application of power they differ little from the automatic looms of the great mills of today, but the mechanical difference between them and the real hand looms of the Peruvians is immense. The nearest approach today are the Oriental rug and the high tapestry looms. In these all weaving operations are done by hand.

There are four points about weaving to be considered: first, the drawing in, or securing the warps in the loom in an untangled condition, at the proper distance apart, and at the correct degree of tension. Second, the shed, or separation of the warps for the insertion of weft. Third, the insertion or picking of the weft through the sheds. Fourth, the beating up the weft so as to form a compact fabric.

The Peruvian loom consisted of two sticks, one at the top and one at the bottom. In certain tapestry looms, when it was desirable to allow the warps little play, they were fastened directly to the loom bars. (Fig. 13.) But in most cases the warps were strung over strings of soft yarn, and these yarns attached, by a second string to the bars. (Fig. 14.) Assuming that the warp chain described under yarns was the form warps generally took before weaving, this was the method: a skein, as long as the desired web, was slipped on the loom string; the warps were separated into small equal groups, and the binding string, secured these important separations and fastened the whole to the loom bars at top and bottom, thus performing the divisional function of the modern reed. The importance of this separation into groups lay in the fact that this enabled the weaver more readily to manipulate the desired warp groups. At the top of almost every web, that is at right angles to the warps, runs a selvage which binds the warps into the unit groups convenient for weaving. The ordinary selvage runs at right angles to weft and parallel to warps and is generally absent in primitive textiles. However, it occasionally appears in the fabrics under discussion. The object served by attaching warps to the loom string instead of the bar, was, that the former had greater elasticity, and took off the warps a great part of the strain, incidental to weaving. Tension was obtained by tying the loom bars at the proper distance apart. Certain stakes, with carved heads, found in the graves may have been used for this purpose. One bar may have been secured to the weaver and the other to stakes. The

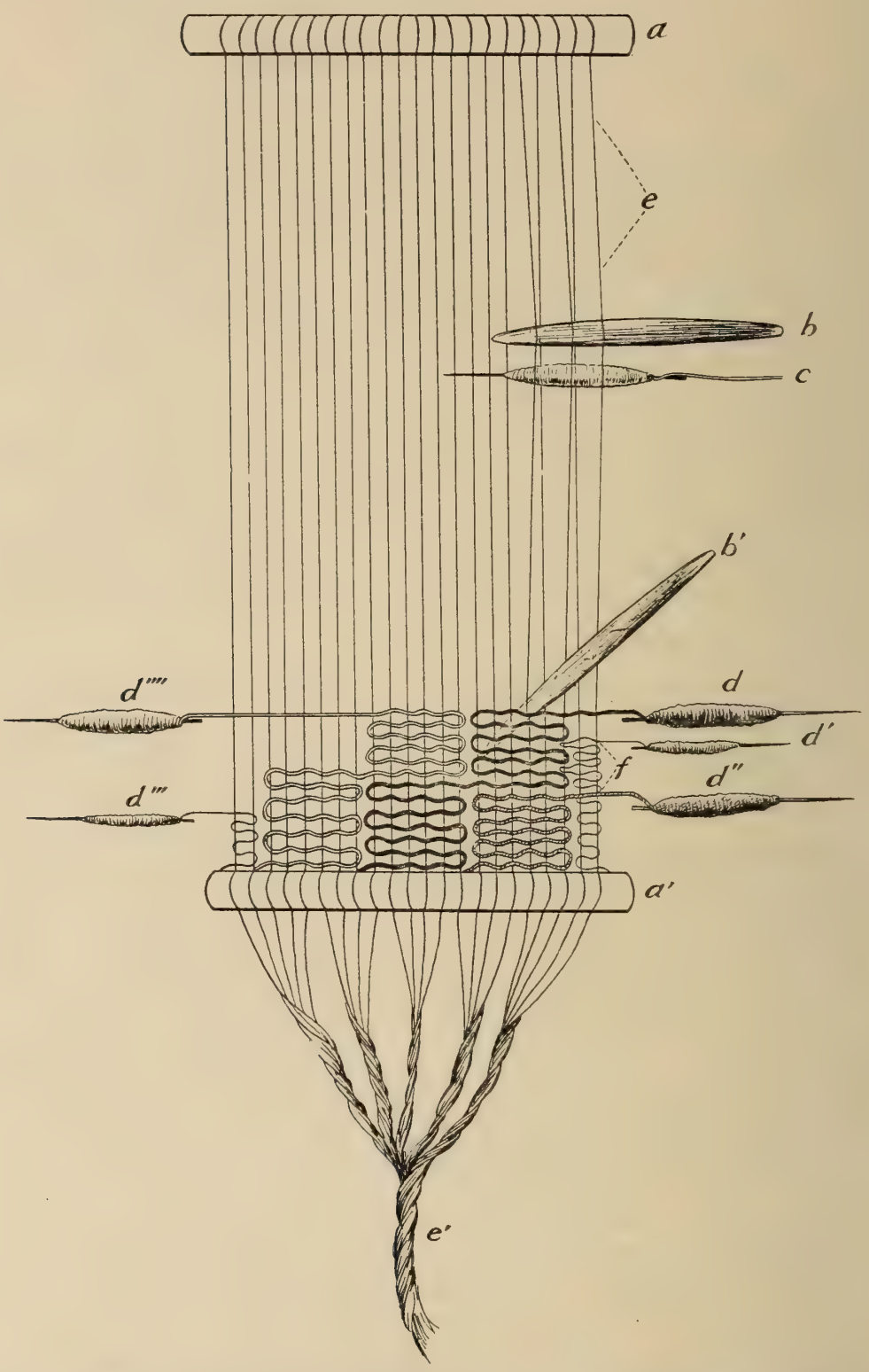

Fig. 13. Diagram of a Peruvian Tapestry Loom. *a*, *a'*, Loom bars; *b*, Weave dagger forming short shed; *b'*, Weave dagger beating up pick of weft just delivered by bobbin (*d*); *c*, Bobbin of weft being drawn through shed formed by (*b*); *d*, *d'*, *d''*, *d'''*, *d''''*, Bobbins containing the different colors of yarn required in fabric; *e'*, Warp twisted from small groups to avoid tangles; *f*, Yarn from bobbin (*d'*) closing up slit in weaving; *e*, Shed formed by weave dagger (*b*).

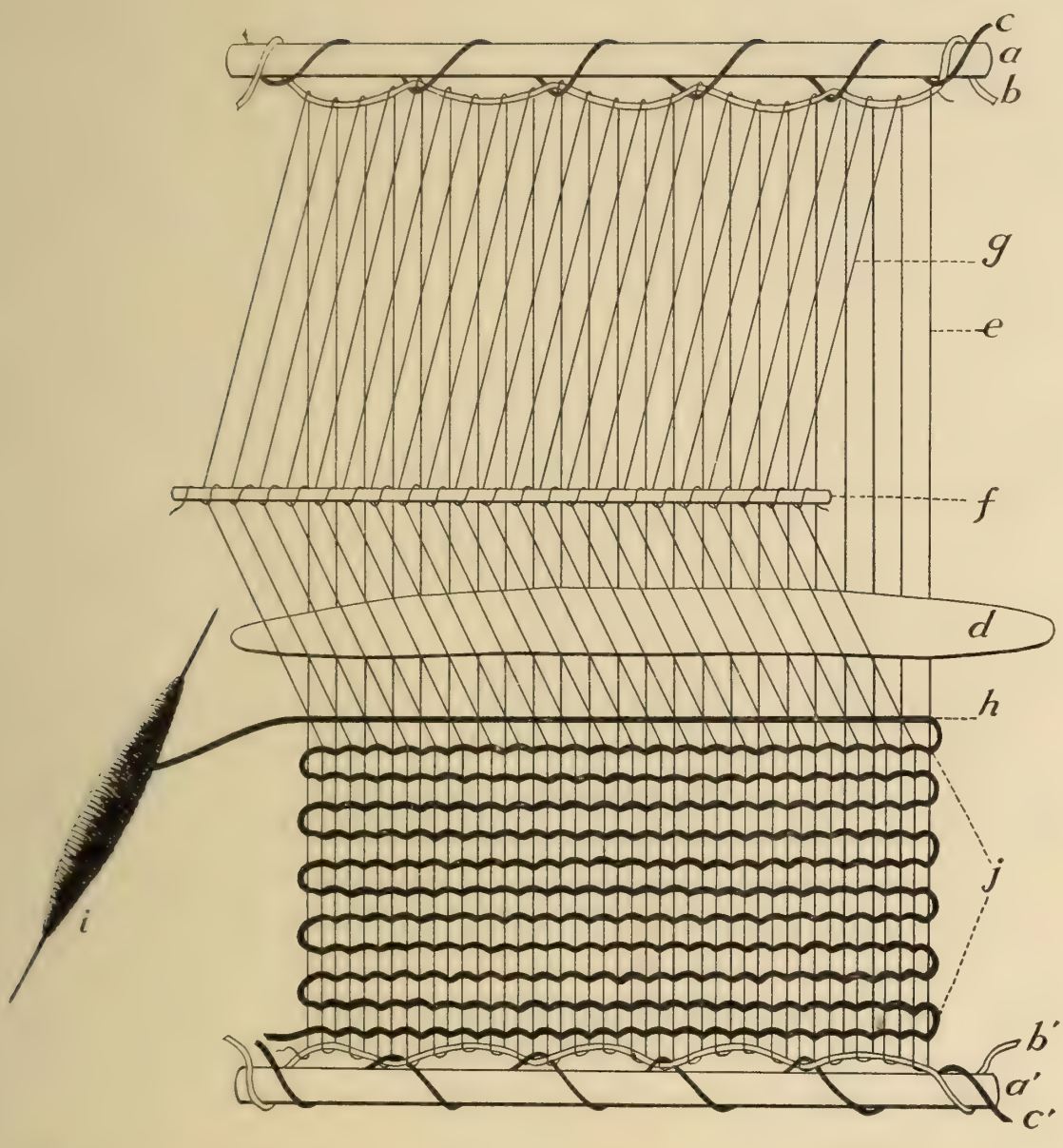

Fig. 14. The Common Type of Peruvian Loom. *a*, *a'*, Loom bars; *b*, *b'*, Loom strings; *c*, *c'*, Binding strings; *d*, Weave sword beating up weft; *e*, Warps not attached to heald rod (*f*), hence not lifted; *f*, Heald rod lifted to form shed; *g*, Warps attached to heald rod (*f*) and raised to form shed; *h*, Weft just delivered by spindle; *i*, Spindle after inserting pick of weft (*k*); *j*, Fell of cloth (already woven portion of web).

upright looms were secured to the boughs of trees at the top, perhaps, and to stakes at the bottom.

The one pure shedding device was the heald rod. (Fig. 14 f.) This was a straight stiff stick to which was secured a yarn containing many equidistant loops. This was arranged on the loom so that every other, or odd numbered warp, ran through a loop. Now it is obvious that the lifting of this heald would divide the warps into what is called a shed, or opening for the insertion of weft. Sometimes a second heald was used; if so, the warps not contained in the loops of the first heald, or the even numbered warps, would run through the loops of the second heald. In this case alternating sheds could be made by first lifting one heald, inserting weft, lifting the second, inserting weft, and continuing the alternation until the end of the warps.

In the absence of the second heald, the weave sword was employed to raise the even numbered warps. Of course, this description applies only to the formation of a plain web. In their designed fabrics they relied rather on their skill with the wefting implement than in any complicated shedding devices. However, it was always necessary to keep count of the warps in order that designs might be kept even. Therefore, each pick of weft made it necessary to keep track of the number of warps to be covered. Now designs were often regularly repeated, and therefore the same sheds were often required; hence when the weaver first counted the warps, he secured the sheds by inserting short pieces of cane, and pushing them to the top of the loom out of the way. By this means much useless counting was avoided. A large number of these pieces of cane are found in the graves, sometimes even in looms containing unfinished webs. In a sense, they are the germs of the wonderful shedding device of the Jacquard loom. But at best these shedding devices were very rude and the production of design was only slightly aided by them. They were a convenience, rather than a necessity, as the weaver relied on a skilful use of the bobbin. In most tapestry and bobbin-weaving, it is doubtful if they were used at all. In this class of work the insertion of the weft is more nearly described as darning than weaving.

The implements for inserting weft were, the tri-part and banded spindle, and the bobbin. The two former have been described in the chapter on spinning. (Fig. 11.) The bobbin was a slender polished piece of palm wood about six inches in length and pointed only at one end. The other end was slightly grooved near the unpointed end. This groove appears to have been burned in, not cut. The object of this burning was to avoid rough edges that might cut the delicate yarns which were continually being fastened in it. (Fig. 15 a–c.)

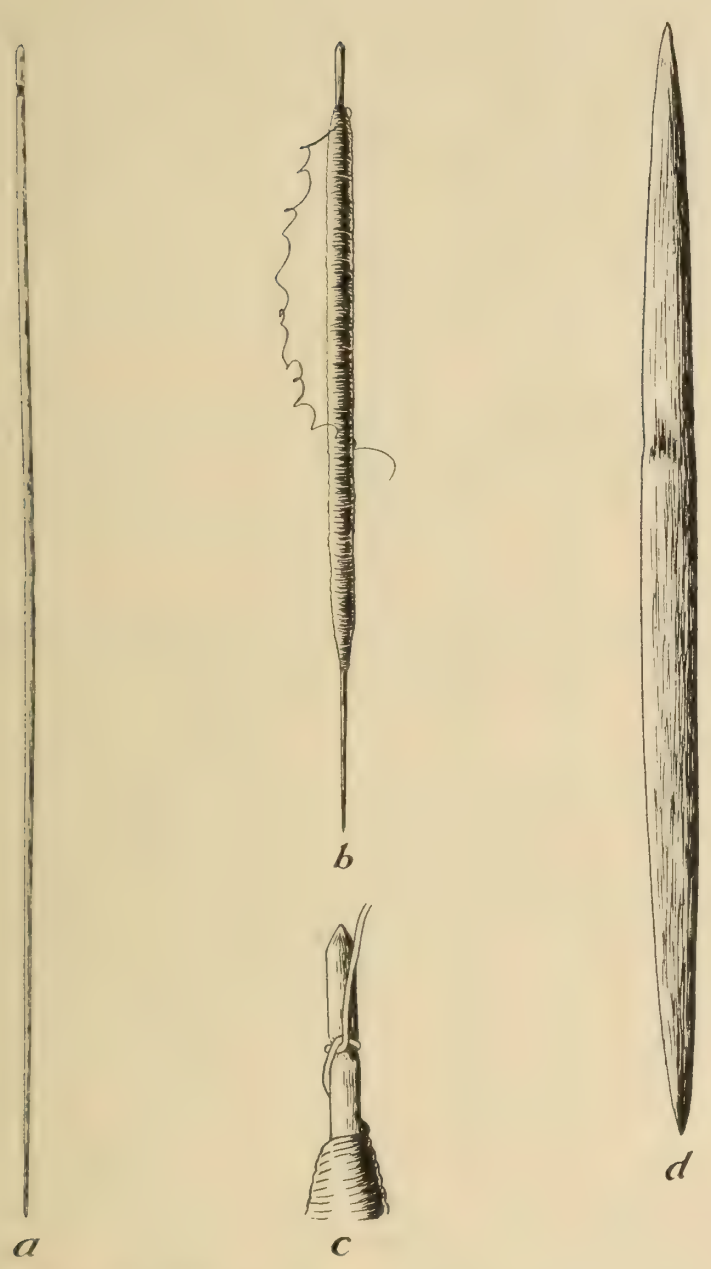

Fig. 15. Weaving Implements. *a*, Empty bobbin showing groove at blunt end; *b*, Full bobbin with weft unwound ready for inserting; *c*, Detail of blunt head of bobbin showing probable method of securing weft before picking; *d*, Weave dagger.

As has been observed, the shedding devices do not appear to have been used in weaving figured tapestry. Weft was laced through only such warps as the figures required, and did not make the complete traverse of the warps as in true weaving. The weaver counted the requisite number of warps and separated them with a finger and then drew the weft through. One cardinal feature of this class of fabric must be borne in mind. I refer to the fact that tapestry weft is picked-in slack, not drawn tight as in other styles. This would be almost impossible if the yarn were allowed to unwind as the bobbin was being drawn through, as the necessary tension to effect this would cause the weft to be drawn tight between the warps. For this reason, it seems proper to suppose that a length of weft sufficient for the figure was first unwound, and then secured to the grooved end of the bobbin and lastly drawn through in such a slack condition as to permit the beating up to fully cover the warps.

Consideration of the following facts will make the importance of this apparently insignificant fact quite plain. As is evident, a pick of weft as first inserted, covers a spot on the surface of every other warp. On the back

Fig. 16 (B-8758). Ornamented Weave Sword. Length, 57 cm.

it covers spots on the warps which correspond to the bare spaces on the surface; but in the greater part of Peruvian tapestry both sides are exactly alike and no warps can be seen. Indeed, in the finest examples, except where wear has obviously frayed the weft, a powerful lens can detect none. Therefore each pick of weft has been so firmly beaten up as to cover the bare spaces left by the previous weft. If too much force were applied in the beating up, the weft would be destroyed. The only other method of accomplishing this is by inserting weft in such a manner as to allow covering the warp without too severe a beating up. That is, weft must be beaten up out of a straight line. This is obviously slack wefting. The weft itself when pulled out shows this beyond doubt, for the warp dents in it are so deep as to bury half the circumference of the warp.

The bobbin (Fig. 15 a, b) was certainly the implement employed in weaving the finest examples of what has been termed bobbin-weaving, in which design is created by weft crossing prearranged groups of warps. The same consideration of slack wefting occurs in this style of weaving. I am inclined to believe that the warps in tapestry and in bobbin-weaving were under a higher degree of tension than in the other styles of weaving. To this conclusion, the absence of the loom string in some of the Peruvian

belt looms points. If, as supposed, the shedding was by hand, then the advantage of a wefting implement less in circumference than the large spindle-bobbins will be quite plain. However, in the unfigured tapestry, great continuous lengths of weft of one color have been employed, and therefore the most plausible explanation of the bobbin is that it was the most convenient form to hold the short lengths of yarn required for the figured webs.

In all other styles of weaving the banded spindle and the tri-part spindles were used as weft containers. The way in which the cops are formed leads to the conclusion that weft was allowed to unwind as the wefting implement was being drawn through the shed. The characteristics of these tools have been explained under the head of spinning. The greater length of the tri-part spindle made it more convenient for use on the wider looms. It must be borne in mind that the spindles were passed through the sheds from hand to hand, not thrown.

The operation of beating up the weft was accomplished in two ways and by two distinct implements. The first and common method, was to insert the weave sword, or batten in a shed after the pick of weft had been inserted and to drive it into the crossed warps by a series of sharp blows. (Fig. 14 d.) In such places as it might catch, it was forced home with some pointed piece of wood or bone, perhaps the tip of the spindle. This is the method employed by most users of this kind of loom today. But when textiles reached a certain degree of fineness such a crude method no longer sufficed. In Asia a comb is used, the teeth of which penetrate between the warps at right angles to the weft, not as the batten through the shed, parallel to the weft. Many combs resembling weaving implements are found in Peru, but the weight of archaeological evidence against their use as other than hair ornaments is so complete as to make it next to impossible to ascribe to them any textile function. There is, however, a narrow, thin, edged wooden implement which could have been pushed between each pair of warps to beat up weft on the same principle as the comb. This is found in almost every basket containing fine fabrics and I have called it a weave dagger (Fig. 15 d).

Two types of loom are shown in the illustrations (Fig. 13, 14), both are diagrams of looms in the Museum. For clearness, only one heald rod is shown lifting warps. Many Peruvian looms had two and I am inclined to believe that in double cloth weaving four must have been employed. The narrow loom without loom string was employed where great tension was desired, and where the small number of warps made the careful division into unit groups less necessary. But how little the loom influenced the nature of fabric produced may be judged from the fact that many fabrics contain three distinct classes of decoration. The change from one type to the other was apparently under easy control of the weaver.

FABRICS.

Cloth is the interlacing of two sets of yarns. It had its origin, no doubt, in basket-making. A portion of a wicker bag in the Museum ornamented with colored wool yarns, may be an example of how basket-making gradually merges into weaving. There is reason to believe that some of the oldest fabrics were rather for decorative than protective purposes. However this may be, it is certain that in primitive weaving the decorative motive appears early, and, with the gradually acquired knowledge of the craft, many ingenious methods of varying the monotony of plain fabrics were discovered. It may be said that there is no process of decoration known to modern textile science but had its origin in some hand craftsman's brain. The philology of such words as shawl, carpet, chintz, calico, gauze, bandanna, and satin, and the plan of the eighteenth century loom, plainly show the Asiatic origin of our textile industries. Roughly speaking, we have but applied steam, water, and electric power to ideas advanced to unsurpassed perfection on the Indus and the Ganges when our forefathers were still satisfied with the pelts of animals and the coarsest of linen and wool fabrics for protection against the cold. No doubt India borrowed something from China, Persia from both, and trade for centuries with Egypt must have resulted in the interchange of ideas as well as commodities. And yet, with the exception of roller and block printing, at least some form of all the combined processes of these great textile masters of antiquity are found in the sand-filled graves of ancient Peru. Some forms are more highly developed than others, and perhaps the different degrees of excellence may be a key to the priority of the different processes. However, the Peruvians were capable of producing many of the same figures in all the distinct techniques and some of their fabrics have never been equaled. I am aware that this is a rather startling announcement, but the proof lies in plain sight in the cases of the Museum; and furthermore, certain skilful expedients of the weaver's craft were unknown outside of Peru, and certain of the finer fabrics, the writer believes after careful search and through inquiry, have never been equaled from a technical point of view.

By far the finest examples of the textiles of Peru and certainly the most widely known of all the fabrics from this interesting country, are the tapestries. What little reference is contained in modern technical writings on primitive Peruvian weaving is to them exclusively. Their marvelous dyeing, the most delicate shades of which have defied an antiquity that makes

the oldest European tapestry seem as a thing of yesterday, and their interesting design treatment will not be here discussed. Suffice it to say, that geometrical and conventional figures appear and their puma, jaguar, fish, bird, and human forms underwent marvelous changes, partially dictated by a savage sense of art and also by the obvious limitations of weaving as an artistic expression. As to their colors, the range of shade is very remarkable, and certainly no better dyeing has ever been done, but this article deals with technical features only.

Tapestry has been aptly described as embroidery on bare warps. Each color only covers such warps as are required in the figure. Weft completely covers warps. Warps are occasionally treated in groups of two or more, but whatever the unit, the weft crosses over or under not more than one unit at a time. Where two colors meet on opposite warps it is obvious that a slit must occur. These slits are joined in the following manner: —

The weft of one color, locks with the weft of the other as shown in the illustration (Fig. 17). A sharp unbroken color contrast is the result. This is weft locking. Another method of overcoming this difficulty is to allow a single bare warp to come between the colors. This warp is then wrapped with a black weft. This black weft at the desired spot takes a turn around the nearest warp in one color, around the single warp and then around the nearest warp in the adjoining figure. Thus, besides a contrasting black line between the colors, a slight dash of black enters each figure. The result is very artistic. This method of closing the slits is called warp locking. (Fig. 18.)

The slits were done away with, in a third class, by the manner in which the weft was inserted. In almost every known form of weaving the crossing of warp and weft is at right angles. Only in the Coptic tapestries and those of Peru is there ever any deviation from this rule. The ancient Peruvian weavers evidently had wonderful control of the bobbins, since weft was picked at every angle; sometimes almost parallel with warps. In this way the openings between figures were closed, and in some cases by surrounding a figure with a binding weft a raised effect was produced. For want of a better name this class of tapestry is called eccentric weft (Fig. 19).

Another form of warp lock appears in a narrow border of a contrasting color on a tapestry ribbon. The weft from the border, for two picks, is laced with the nearest warp as shown in Fig. 20.

The fourth class of tapestry appears as the border to a plain woven fabric. It appears to be sewed on, but in reality the warps run down from the fabric into the border. For artistic effect the border is made heavier. This is accomplished by combining a number of the warps, generally three, into one warp for the tapestry. To prevent slipping, the outside single

warps of each group of three have been crossed. The illustration shows this more plainly than can any description (Fig. 21). Sometimes four warps were thus combined for warp in the border but were not crossed.

A distinguished expert on Oriental carpets, Mr. John Kimberly Mumford, is authority for the statement that no Kelims were ever woven as fine as some of these Peruvian tapestries; and, of course, no European

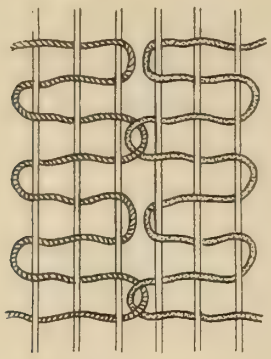

Fig. 17.

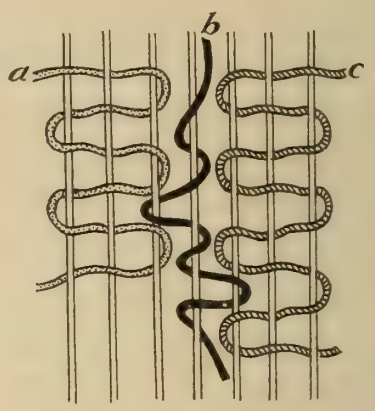

Fig. 18.

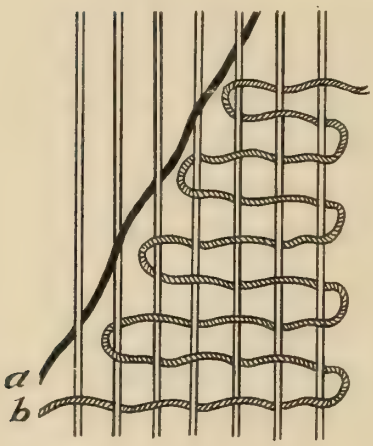

Fig. 19.

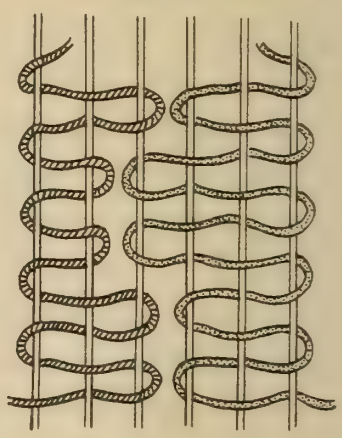

Fig. 20.

Fig. 17. Weft Lock.

Fig. 18. Method of closing Slits by employing an intervening Warp covered with black Weft between the two Colors. *a*, Weft of first color; *b*, Black weft covering intervening warp; *c*, Weft of second color. The black weft takes a turn around the nearest warp in the figure covered by *a*, around intervening warp, and around nearest warp in the figure covered by weft *c*.

Fig. 19. Detail of Eccentric Weft. *a*, Weft outlining figure; *b*, Ordinary weft inserted at right angles to warp.

Fig. 20. Method used to close Slits when weaving colored Border to narrow Tapestry Ribbons.

tapestry compares in fineness with Oriental craftsmanship. It must be understood that this comparison is entirely apart from design and deals only with the dyes, the yarn structure, and the number of warps and weft to the square inch. Gobelins seldom contain more than twenty warps per inch. The number of weft is not stated, and the writer has never been

able to use a high power counting glass on these works of art. The finest Peruvian tapestry analyzed gave the following amazing result: warp three-ply, 150 cotton warps, forty-two per inch; weft two-ply No. 250 vicuña, 260 to 280 picks per inch. The sample referred to is B–1225. So close was

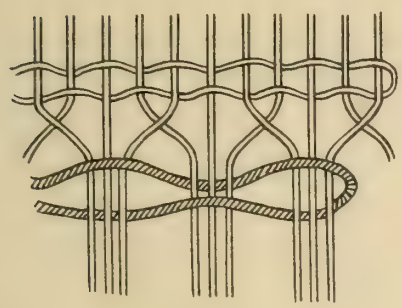

Fig. 21.

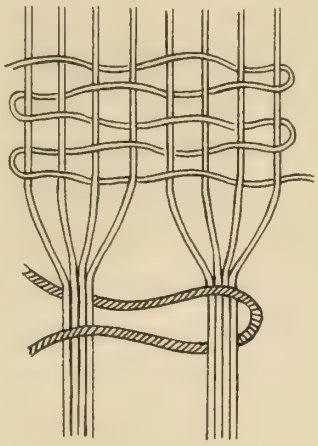

Fig. 22.

Fig. 21. Skilful Method of combining three Warps of a Plain Fabric into one of a Tapestry Border.

Fig. 22. Method of forming Tapestry Borders by combining four Warps from a Plain Fabric to form one Tapestry Warp. There is no crossing of warps as in Fig. 21.

the texture of this unrivaled web that the most powerful counting glass could not make a certain test. It was necessary to pick the weft off the warps with a needle under a powerful dissecting microscope. Several perfect specimens in the Museum appear to be as fine, one at least, finer, but they are in too perfect a state of preservation to be subjected to such a severe analysis.

Few of the comparatively coarser Peruvian tapestries are as coarse as Gobelins. Ply yarns carefully spun for this kind of weaving, appear universally. The great abundance of tapestry webs and the very advanced state to which the art was carried, places it easily at the head of Peruvian textiles. True woven designs in which figures were formed by the manner in which the weft crossed prearranged groups of warps were carried to a high degree of perfection. Considering the primitive methods employed in shedding, it is remarkable that such designs could be worked out. This is conclusive evidence, if any were needed, of their ability to carry each detail of a complicated design in their minds, for here the appearance

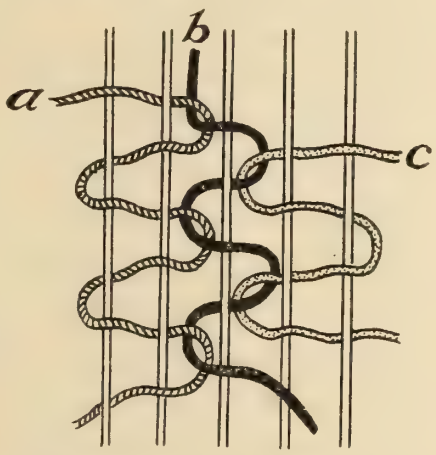

Fig. 23. Method by which each Pick of Weft is locked into the next Pick.

and disappearance of each weft across the entire warps had to be considered.

One type of bobbin-weaving requires so careful a consideration of weft appearance and disappearance and the ability to carry a preconceived arrangement of color and design of such remarkable complexity as to deserve especial mention. In this class of weaving both sides are finished, the color appearing on one side as designs, on the other as background and vice versa. It must also be borne in mind that unlike tapestry each pick of weft covered the entire width of the warps and also crossed groups of warps of different numbers in forming designs. Sample B–5917 is the border to a tunic. The design is a repetition of the bird figure in slanting lines. The colors are red and yellow. No warps show on the surface. The birds and the lines are red with yellow dots on one side. The bird's eyes are yellow with a red dot in the center and the background is yellow. On the reverse side the birds are yellow, red eyes, yellow dot-lines, yellow, red, dots, background red with yellow dots. In other words, the weaver had to arrange the insertion of each pick of weft so as to form designs on one side and background on the other. It is virtually a double set of weft on single warps. The very finest example of this nature appears in a stripe in B–1225. It must be understood that every appearance and disappearance of weft on face and reverse had to be arranged for beforehand in order to produce design by this method. It falls in the same class as Jacquard weaving. In Peruvian craftsmanship this class of fabric differed from other woven design in that weft was beaten up in the same manner as in tapestry, and owing to the frequent change of colors, the bobbin instead of the spindle-bobbin was used as a wefting implement. To distinguish it from other woven designs the name bobbin-weave has been applied.

A large number of fabrics have been made by what is styled two-beam weaving or double cloth. Modern examples are the old blue and white blankets of the early nineteenth century and certain fancy blacked and plain-faced cloths fashionable in overcoats within the last generation. The method of weaving was as follows:— Two sets of warps of different colors were placed in the loom. Each warp was picked with the same color weft. If this were continued without variation two separate cloths would be left on the loom, but if one set of warps for a certain space be raised above the other and picked with the same color weft, and the other set lowered and picked with its weft, the result would be crosses that lock the fabrics together. To this class belongs a large number of cocoa leaf bags and the figured portions of the little charm bags buried with the mummies. The singular feature of this textile is that the design will be one color on the face and another on the back. At the edge of the figures the lock takes place.

In unfigured spaces the two fabrics can be separated. The finest example of double cloth weaving examined appeared in a bag and is numbered B–4660 in the Museum catalogue. The colors are brown and white, combined in a well-balanced design consisting of small geometrical figures. Each of the combined fabrics contains 48 warps and 48 weft per square inch or 96 by 96 in both. It is interesting to note that all Peruvian double cloths are square in count, that is the number of warp and weft yarns are equal. Other specimens examined were 22 by 22, 36 by 36, and the above 48 by 48. The yarns are cotton, white, and dyed brown, two-ply, perhaps about No. 40–48 warp and 48 weft per square inch in each of the cloths.

Peruvian embroideries also show a remarkable degree of skill. However full the design may be, it seldom shows on the back of the fabric. Most fabrics embroidered on were of cotton and had either a double warp or weft, sometimes both double and untwisted. How carefully the stitches were counted is evident in that class in which the needle has picked up the ground threads in such a manner as to create designs on the embroidery itself. For a clearer comprehension of the style I have named this double design embroidery.

Now of all weaving tricks tubular weaving seems the most unlikely for the primitive craftsman to stumble upon. Today the most common example of this class is the pillow slip. Yet in the Peruvian collection we find a narrow tubular ribbon in which the warps of great variety of color produce design. In order to make the texture solid, the colors on one side have been drawn through to make designs on the other. This is an application of the principle of double cloth weaving. Tubes without this crossing of wefts appear as borders to certain tunics. They are generally filled in some manner.

Crocheting was another method of decoration in Peru. This was done with great skill. In some cases three stripes of crochet were joined together in such a manner as to form single designs. The parts of the figure appear in each strip and are correlated only when combined. Besides this, designs were crocheted and attached with their own yarn as ornaments to a basic fabric. Certain very rare rugs known as Cordovas have the same style of decoration.

Certain very interesting lace bags were made from a bast fiber. The micrographs of this fiber resemble hemp, perhaps maguey or cactus. No people, without borrowing ideas, are supposed to have made use of more than two of the world's four great textile fibers and yet the ancient Peruvians, were able to use three with great facility. Most of their cordage was of this fiber and nets were also made from it.

Net-making naturally suggests the weaving of lace and sure enough at

least two examples of this dainty material are found besides the bags noted above. Several examples of tied dyeing are in the collection. The Indian name for this is bandhana from which the cheap gaudy handkerchief takes its name. It has heretofore, always been considered a purely Asiatic craft.

A very curious and at times confusing characteristic of Peruvian webs was the ease with which they passed in the same web from one style of technique to another. Plain weave, tapestry, and embroidery often appear in the same fragment. Apparently it was as easy to produce design by one method as another. This is good evidence, of how small was the influence of the style of loom, the sudden and amazing transpositions giving the artists an opportunity for proper expression and freedom to demonstrate their peculiar skill. From the size of the web it seems certain that most of the fabrics in the collection were intended for bodily ornament, some few may have been hangings, but it is extremely doubtful if any were used as floor decorations in the sense that rugs now are.

Some mention must be made of the rough but useful sleeping mats. These were made with tight twisted two-ply warps and very heavy two-ply slubbed cotton weft. The extreme dryness of the climate made cotton a better fiber for this purpose than wool. Very skilfully made tassels also appear as a border to woven fabrics and sometimes a series of large ones were formed into what appears to be a girdle.

The pile knot appears in certain ornamental cordage. The knots have been laced with one thread and then caught in a core composed of three threads. A few small fragments of belts, with a design similar in surface appearance to Oriental rugs, is one of the most remarkable exhibits in the Museum's collection. This method of producing designs has always been considered as Asiatic in origin, and the discovery of undoubted specimens of a pile knot fabric in ancient Peru is most astonishing. The knot is rather simple and the number per inch about twenty. In one example five colors have been used.

Brocade weaving appears in some simple designs. This method of decoration is by the inserting of yarn of greater diameter and softer twist than the weft of the cloth and appears on the surface only where the design calls for it. Its soft character allows the weft of the fabric to be beaten up and buried under it. An example of this style of weaving appears in a partially completed condition, on one of the looms in the Museum exhibit.

A large class of Peruvian cloths come under the head of crêpes and voiles. That is, pleasing crinkled effects have been produced by the use of super-tight or crêpe twist in the yarns. This allowed for very open fabrics and the friction-producing twist prevented slipping. In some instances a

reverse twist weft was used with great effect. One piece containing heavy tapestry stripes of varying width, combined with crêpe stripes would furnish a possible design for use today.

One Peruvian method of producing design is most interesting in its technique. In appearance it closely resembles those fabrics in which the plain weft has been either omitted or cut out and a figure of different color darned in. Certain Chinese tapestries have been made in this way, but the technique of the old Peruvians is very much neater and resulted in a firmer texture. The specimen examined is a white cotton crêpe with brown figures. In the figures the weft is brown and although the weft in the basic fabric is white, there is no trace of it in the figures which are composed of brown weft and white warp. The white was inserted to the edge of the figure, then turned back, the brown weft crosses the figure, loops into the white and turns back. Certainly this is evidence of a great degree of patience and desire for perfection almost incomprehensible. To the writer's knowledge no such technique has ever before appeared in any textile.

In most Peruvian weaving the peculiar slack weft characteristic of tapestry appears. This allows for the partial or complete covering of warps. This fact, taken in conjunction with the unrivaled fineness of their best tapestries, leads the writer to suggest that this form of woven design was the oldest in Peru and, judging by analogy, in the world. It may be said in this connection that the earliest form of Oriental rug was the unpiled Sehna Kelim.

Space does not permit the complete analysis of every fabric examined and properly such a list should appear in a catalogue. To the writer's knowledge no such opportunity for the study of the uninterrupted textile development of a people, free from outside influence has ever been presented and he feels that this paper is but an introduction to more exhaustive research.

There is in the Museum a beautiful veil of gossamer lightness which contains heavy medallions of embroidery. No illustration can do justice to this exquisite piece. How a fabric of such lightness could have stood the insertion of such heavy figures is a mystery. The background is a kind of open voile, the yarn is brown cotton about No. 250 or finer and of most amazing twist. The embroidery is two-ply dyed cotton No. 80 perhaps; except the yellow which is two-ply vicuña. No pulling is evident in the stitches.

What may be called the common textiles of Peru, resemble our lighter ducks. The yarns were two-ply cotton, warp much the tighter twist. In this class belongs an interesting cotton homespun. The yarns are contrast twist, brown and white cotton combined. Often these ducks bore painted

designs. Another method of decoration was using stripes of colored warps or wefts or combinations of both in patterns strongly suggestive of modern ginghams. Some of these ducks are remarkably fine and resemble tapestry in appearance, except that it is the warps which greatly predominate in number.

That class of fabrics known as gauze, familiar to us in certain curtains, is well represented in the Peruvian techniques. The peculiarity of this fabric is that pairs of warps are twisted together and the crosses made permanent by the insertion of a pick of weft. It has always been considered that this weaving trick originated in India, but the old weavers of Pachacamac used it with great freedom producing many fancy designs with great ease. The designs were formed by skilfully combining or separating the groups into which the warps were twisted.

The bast fiber used in the twines is rather coarse, showing rough heckling resulting in fibers very uneven in diameter. The lace bags of bast fiber are made of much finer fiber as the nature of the yarn clearly indicates, but by far the greatest skill in handling this staple is in certain linen like fabrics resembling the older mummy cloths of Egypt. Here the fiber shows unquestionable evidence of a high degree of preparation. The extreme fineness and the amazing regularity of diameter lead to the assumption that some form of heckling must have been employed. From certain facts to be noted, it is the opinion of the writer, that the rarity of this kind of fabric in Peru, in a woven condition, was because this class of yarn, made under the most ideal conditions did not lend itself readily to the exquisitely even textiles of Peruvian weavers, rather than to any lack of knowledge of its spinning qualities. Lastly, linen is best adapted to a moist hot climate, whereas the dryness of Peru is proverbial. Of course, Egypt was naturally the same, but the yearly inundation of the Nile caused what may be styled an artificial dampness. The two Peruvian examples examined indicate a much more extensive use and greater knowledge of this class of staple than the small number of examples in the Museum's otherwise wonderful collection seems to indicate. The fiber is very fine, so fine indeed, as to strongly suggest true flax. The yarns are well spun and very even. The finest fabric contains 80 two-ply warps about as fine as No. 32 two-ply cotton, 60 weft about as fine as No. 36 cotton two-ply. The maguey fiber of today is made into some rough native cloths, but in our mills it is considered too coarse for anything but rough bagging and harvester twine.

DESIGN TECHNIQUE AND WEAVING TRICKS.

The figures best known to the student of Peruvian art, are the human figure, the cat, the fish, and the bird, and the conventional representations of the same. This chapter does not deal with the consideration of design that was obviously intended to convey some concrete idea, however vague, but rather with forms of textile decoration that spring almost spontaneously from the mechanical combination of warp and weft in a fabric. It is not amiss, however, to draw attention to the fact that so far was weaving skill advanced that these designs could be produced with equal facility by at least four principal mechanical methods of weaving, such as tapestry, bobbin or true fancy weaving, embroidery, and double cloth. Even in lace, pile knot, and gauze fabric the same figures may be said to find a place.

Let us first consider the weft as a decorative yarn. Its purpose in tapestry is quite obvious. Here it is the sole decorative element. Embroidery may be classed as a kind of weft decorated fabric. What I have styled bobbin-weaving, is another class, almost as important as tapestry, in which weft is the sole apparent ornamental element. Here the warps are covered as in tapestry, but owing to prearranged appearance or disappearance of weft over or under unequal groups of warps, the latter may be said to have a secondary decorative function. Stripes made by the insertion of colored weft appear both in certain tapestries and plain webs.

A very interesting group of textiles is ornamented with warp stripes. So cleverly have some been woven as to leave not a trace of weft. At first sight they appear to be true tapestry, and the tendency to mistake warp for weft is very natural, but fabrics woven by passing a bobbin of weft from hand to hand, with very few exceptions, rarely exceed twenty-seven inches in width. If we erroneously assume the warps of these fabrics to be wefts, we must then assume that they wove fabrics six feet four inches wide and twenty-two to twenty-seven inches long. From this absurd supposition, we are saved however, by finding the characteristic loom strings at the ends of the long yarns, thus establishing them as warps beyond question. The stripes were caused by drawing in the warp in groups of colored yarn, such as the width of the stripes required. In this class of design the warps outnumbered the weft generally more than two to one. Perhaps, the warp predominance may not have as great a weft in tapestry, but I assume only for the reason that these fabrics though fine, were not carried to the exquisite degree of excellence achieved in the former. The finest example was B–5449 in which the warps were 104 per inch and the weft 34.

Combinations of warp and weft stripings produced patterns, many of which appear today in our ginghams. A very interesting comparative exhibition of these designs might be made from the Museum collection. Shadow stripes were produced by the occasional introduction, generally near the edge, of light colored yarns in the darker stripes, either warp or weft. Fancy and broken stripes were produced by warps being unpicked for a certain number of passages of the bobbin, or by the weft jumping certain groups of warp ends.

What is known as gauze is a fabric in which two warps are twisted around each other and the cross locked by the introduction of a pick of weft. If this order were maintained throughout an entire fabric, it resulted in what may be styled a plain gauze. But occasionally they left warps untwisted for a short distance, and by inserting weft in the ordinary way produced weft stripes or by allowing certain warps to remain untwisted through the length of the web produced warp stripes. Sometimes, designs were made by the order in which the gauze twist was used in the warps as in B–4070. In certain plain weaves, an occasional use of the gauze technique produced simple cross-like figures. By the use of gauze warps in plain fabrics, warp stripes were formed.

Besides greater evenness in strength, ply yarns have a value in art. The light refraction from them is softer than from the singles and they give a much more pleasing effect when employed in weft. In warps their roundness produces very handsome repp effects. At times two picks of weft were run between each shed in the warps. Again, two warps were used as a unit. There are fabrics that contain double warp and weft. This technique varies the monotony of plain cloth and involved little, if any, additional labor. Its purpose was purely artistic. Most fabrics highly embroidered were thus woven.

The knotting on of feathers, sewing on of metal ornaments, the use of tassels and fringes also come under the head of mechanical design. Aside from the actual mummy wrappings, few fabrics, even the coarsest but have some decoration. The use of even the most complicated methods ran through the entire gamut from exquisite tapestries to the coarsest ponchos.

In Egyptian weaving it is very common to find borders sewed on the garments. The Peruvians generally scorned such makeshifts. Almost never was this done. If a border to a fabric was desired it was woven on in the most careful manner. In the same piece they changed from plain warp stripes to double cloth with a tapestry border or stripes of bobbin weaving with narrow tapestry border, or embroidered plain cloth with tapestry edge. In fact, almost every fabric showed their wonderful mastery of the loom.

To classify the mechanical designs, the following generalities may be useful:— In tapestry, bobbin-weave, and to a lesser degree brocade and embroidery, weft is the sole decorative yarn. Here weft greatly outnumbers warp. The coarser bobbin-weaves contain about 24 warps per inch and 72 weft; the finest tapestry 44 warps to 280 weft. Warp stripes, as the name indicates, contain about three times as many warp as weft. The finest example contains 104 warp and 36 weft. In the plaids, warp and weft appear nearly equally in design, varying somewhat with the weaver's idea of beauty. In the double cloths warp and weft appear equally in design and here the counts are exactly square as given above.

The necessity for covering so large a field within the limits of this article leaves little space for the technical discussion of special fabrics. In a second paper the writer hopes to give complete analyses for a large number of the characteristic weaves and diagrams of the distinct technical methods. Yet I have selected four examples, not more interesting than many others, but sufficiently unique, to show the craftsmanship of the whole.

B–5449 is a warp striped poncho. The point of technical interest in this piece is that warps have been drawn in the loom in a slack condition so as to completely cover up the weft. The effect is aided no doubt by the crêpe twist spun in the yarn; but even so, the weaver must have aided by slacking off the warps to an almost incredible degree when the number of 104 per inch is considered. The fabric is absolutely even, no puckering or pulling is evident, and the differentiation of the stripes is sharp and clear. It seems a simple point, but ask any hand loom weaver and you will hear a different story.

B–764 is a fragment of an embroidered cotton duck bag. The figures are the conventional bird in a diamond. Warp and weft of the basic cloth run double, but untwisted, two weft to a shed, two warp to a dent. The embroidery yarn has been locked under every pick of weft, except where it appears to form a pattern. Yet, so nicely has its size, the count of the fabric, and the twist and size of yarns been considered that it is scarcely perceptible except in the clearly outlined design. The pattern appears on the back as though embossed but no trace of the colored yarn can be seen. The slight raising of the weft in a repp by the embroidered yarn gives a very artistic effect.

B–993 is a plain cotton fabric with a slight crêpe effect containing cat figures and a conventional diagonal stripe. The design is brown. The fabric is white. In the figures white warps and brown weft appear. The white weft of the basic fabric comes right up to the edge of the figure and is then looped into the brown weft of the figure. Similar figures are woven in certain Chinese tapestries but here the weft of the fabric has been cut out

and the decorative weft inserted. The Peruvian method is much more skilful and shows the great pride they took in even the simpler textiles.

40.1–1152 (Nasca). This is a very interesting narrow tapestry web. The warps are single-ply, very fine, perhaps No. 100, white cotton, and are treated in units of two. The evident intention was to produce a tapestry without the characteristic repp effect. The design consists of three small squares of scroll-like figures. Each square contains two colors, outlined with fine black lines. Where the two colors come together there is always a line of black between for contrast and as each colored weft comes to the black, they are looped into each other. That is, each color locks into a loop in the black weft. There are 72 picks of weft per inch, and in each inch there is an average of eight such locks, making the astonishing total of 576 places where wefts loop into each other in a square inch.

Under the head of fabrics the construction of the very fine tapestries has been considered. This and the later examples have been chosen as typical rather than extraordinary. The effort has been to give a fairly comprehensive picture of their technique, not an account of some particularly fine specimen. Pile knot, gauze, tubular weaves, and lace were somewhat more rudimentary and yet show remarkable skill and their development may rather indicate preference in textiles than any lack of skill. Of the remarkable range and combination of yarn I have already spoken, but I repeat that this vital part of the art was developed to as high a standard as anywhere in the world. In fact, they were complete masters of their tools. If no other knowledge of textiles existed (aside from the application of purely mechanical invention) except such as owed their earliest origin to Peru, there is no great class of fabrics but of which we would have some knowledge today. Apart from all known outside influences, depending entirely upon their own resources, they produced practically every kind of textile decoration and technique known. Our debt to Asia for textile knowledge is too obvious to be disputed, the very philology of our industry forbids, but it is wonderful to consider that each problem had been worked out and buried under the sands of Pachacamac centuries before the first white man set foot on the shores of Peru. It must ever be a regret to everyone who looks upon certain textiles as a high form of art that a race of such consummate craftsmen should have left no heritage of skill to their descendants.

GLOSSARY OF TEXTILE TERMS.

Warp: The threads which run lengthwise in the fabric. They are the ones first placed in the loom.

Weft: The yarn laced into the warp by the spindle or bobbin.

Shed: The space formed by separating the warps so as to insert weft in desired order.

Heald rod: A stick around which a string is looped in such a manner as to attach it loosely to every other warp. Lifting this stick is one method for forming a shed.

Bobbin: A slender stick of wood pointed at one end, containing weft yarn and used as a wefting implement in figured tapestry and bobbin-weaving.

Banded and tri-part spindles: Used in spinning, and as wefting implements in fabrics other than figured tapestry and bobbin-weaving.

Weave dagger: Thin, edged piece of polished wood used for beating up in bobbin and tapestry weaving; also to form short sheds.

Weave sword: Large, heavy piece of polished wood, drawn to a double edge. Used to beat up weft in weaves other than tapestry and bobbin-weave. Also used to form alternating sheds in looms containing single heald rod.

Beating up: Act of forcing last length of weft delivered by spindle or bobbin into cross of warps, and up against portion of fabric already woven. This portion is referred to as fell of cloth; that is, that part of a partially woven fabric already finished.

Pick, weft yarn: to pick, to insert weft.

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PERUVIAN FABRICS

BY

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By M. D. C. Crawford.

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INTRODUCTION

This paper is the sequel to the preceding, entitled *Peruvian Textiles.* In that paper the necessary introductory discussion left little space for consideration of the actual fabrics. This omission has been in a measure remedied in the present work. Here the discussion is almost entirely devoted to the different techniques of weaves. When it is understood that this technology is very nearly as extensive as is that of today, it will be appreciated that within reasonable limits, an exhaustive discussion of each division is impossible.

In order to establish techniques, certain fabrics have been submitted to microscopic dissection. Where it was found advisable, detailed drawings or diagrams have been made. These correspond as faithfully as possible to the fabrics under magnification. In every possible manner, these diagrams were verified, but it must be recalled that not only were the specimens too valuable for the dissection of an unlimited number, but the fineness of texture and the fragile condition must be taken into account as well. Within my knowledge, no collection of archaic fabrics was ever subjected to so rigorous a technical investigation. But this was absolutely necessary. Fabrics, especially if very fine, and often differing in technique from modern webs, can never be fully understood from surface examination, be it ever so patient.

In the following pages reference will be made to certain techniques and designs, which quite closely, and often exactly, correspond to Asiatic fabrics. Comparison of some kind or other was absolutely requisite in order to establish the significance of these weaves. The desire to clearly state the technical properties are all that such allusions mean. On any other question, such as intrusion, I am by no means qualified to write. That the mechanical resemblance is strong and even the artistic expression at least reminiscent, there can be no doubt; but this is perhaps sufficiently explained by the fact that in Asia and Peru, cotton, at least in their textile zenith, become the principal fiber.

This at first glance may sound strange to anyone looking at the handsome wool fabrics, but it will be plain when it is understood that even in these, cotton was almost always used in the warp. Of course, the character of the warp threads strongly influences the type of loom. Again, cotton fiber requires a distinct method of spinning. The fiber is very short and weak compared with wool and bast. It may be here mentioned that there

is a marked similarity in the techniques of both spinning and weaving of Asia and Peru.

Not to enter into too lengthy an explanation, it may be sufficient to point out that finer threads can be made from cotton than from any fiber, except silk. Also, the nature of the fiber makes the yarn very pliable. Therefore, to avoid tangles some form of loom which can exert an even tension on warps is necessary.

The simplest form is the two-barred loom. This type prevails throughout the entire cotton area in the New World. The Hopi of today use a loom differing little, if at all, from those found in the ancient Peruvian graves. The modern rug weaver of the Orient would only need to employ heavier beams or bars to use this form.

The ancient Greeks did not use cotton; bast and wool were their fibers. Hence, we see on their pottery, single-barred, warp-weighted looms, similar in all essentials to the types used by the Chilkat Indians, the Swiss Lake Dwellers, and the inhabitants of Iceland. An apparent exception to this distribution of looms, according to fiber, may be made in the case of Egypt. Here, a people famous for their use of flax, used the two-barred loom. So far as we know, these people never used cotton. The infinite skill they achieved in flax spinning leads me to doubt if any cotton belonging to ancient times will ever be found, for bast appears always to precede the use of other fiber.

This exception is, however, only apparent. The early Nile spinners were so skilful that they made threads from flax only a little less fine than could be made from cotton, that is, taking a fair average of fineness, not the superlative cotton spinning. When such pliable warps became common, the mechanics of weaving eventually forced their invention, as it forced the users of cotton, to the two-barred type. Such a loom is clearly shown in a famous wall painting; but, the earliest, I am inclined to believe, was the single-barred warp weight type. In proof of this, it may be well to state that among very old Egyptian artifacts occur clay objects strongly resembling loom weights. These are sometimes called fish net sinkers, but their similarity to true warp weights is so pronounced as to be worthy of notice.

The textile development of pre-Inca Peru is unique in many ways; but to the student of archaeology it possesses a peculiar value. It is the world's one perfect record of the technical and artistic development of a single people. Here there is no trace of outside influence. From the simple to the complex, from the crude to the perfect, a single people have left their record in the time-defying sands. It should be of interest to students of textile art in the Old World, but its chief value is to those interested

in the fabrics of the New World. For here, the baffling question of Spanish influence is absent and where doubt exists, a comparison of coarser fabrics and designs from other areas with pre-Inca technique or design may be of help.

The most recent additions to the Museum's collection of Peruvian fabrics are the Nazca and Inca collections. These were presented by Mr. A. D. Juilliard. They contain many fabrics of great technical interest as well as artistic value. They are discussed in the following text, but are of such interest as to deserve special mention.

In conclusion, I wish again to acknowledge my obligations to Mr. C. W. Mead, curator in charge of the Peruvian collections. This research was conducted in the infrequent leisure hours of commercial work and without the benefit of his scholarship and unfailing courtesy, must have dragged on indefinitely.

The subject has great fascination. I leave it with extreme reluctance. Virtually only its mechanical and technical phases have received consideration. Its artistic merit, its influence on other arts, and a thorough comparison with similar developments in other parts of the New and Old World, all suggest further research.

June, 1916.

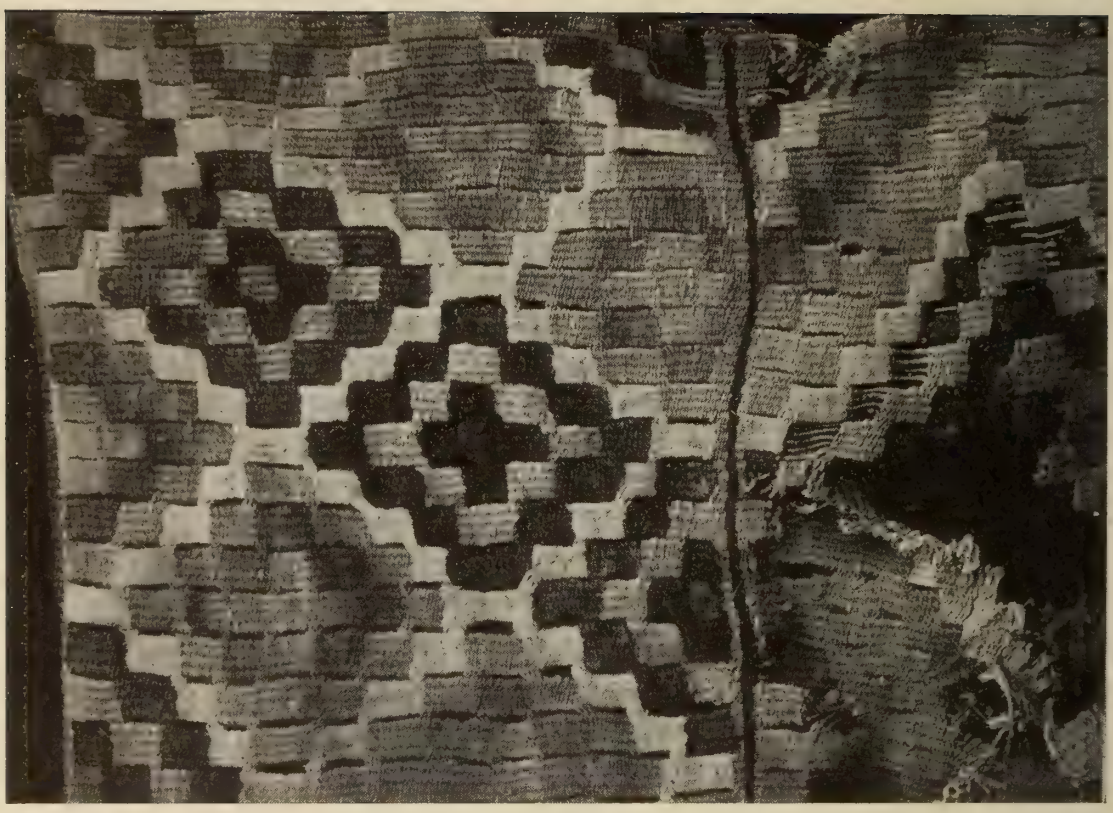

Fig. 1 (B–798). Tapestry showing intentional openings left between differently colored areas ending in parallel warps. The slits are left with a decorative intention.

TAPESTRY.

In tapestry, Peru reached its highest textile development. The harmony of color, the beauty and fastness of dyes, and the perfection of spinning and weaving, place these fabrics in a class by themselves not only as compared to the other textiles of this land, but as regards those of any other people. The patience and skill indicated in the finest pieces passes belief. Many contain nearly three hundred weft yarns to each inch. In the first paper of this series a web containing 260–280 weft yarns to the inch was analyzed. It was impossible to count the weft in this fabric with the testing lens ordinarily used in textile analyses. It was necessary to clamp an inch of cloth on the platform of a dissecting microscope and pick off the weft yarn with a needle. The operation took three and one half hours. The specimen subjected to this severe treatment was in a fragmentary condition, and the destruction of so small a piece was justified in the interest of exact information. When a standard of comparison was thus obtained, it was unnecessary to mutilate the perfect specimens on exhibition. Sufficiently accurate counts could be made by comparing the texture of this specimen under magnification with each piece.

The question naturally arises, how long under the most favorable conditions would it take an expert weaver to finish such a web? It is a rather common belief that the explanation of such fineness is to be found in an almost limitless amount of time at the disposal of the weaver. The fallacy of such a supposition must be apparent to anyone at all familiar with the manifest duties incident to savage or barbarous conditions of life. The only accurate measure of comparison available is the fact that the weavers of the famous Gobelin tapestry finish in a year of work only one square meter of cloth. Perhaps the fact that this is a subsidized industry, in which the workers by no means exert themselves, may account for this slowness. Much greater production is achieved in commercial institutions making tapestry a little less perfect, but the illustration is chosen as the best known and finest example in existence. These works of art are very coarse in texture as compared to Peruvian tapestry, and if we assume an equal amount of skill in weaving both, we must of course admit that the latter took a much greater amount of time. But this assumption is by no means necessary. Hand loom weaving in Europe even at its zenith never reached the development achieved in either Asia or Peru and today has sunk to very limited proportions. The weaver's pay, as compared with other trades, is so low as to offer little inducement to the best mechanics. There is,

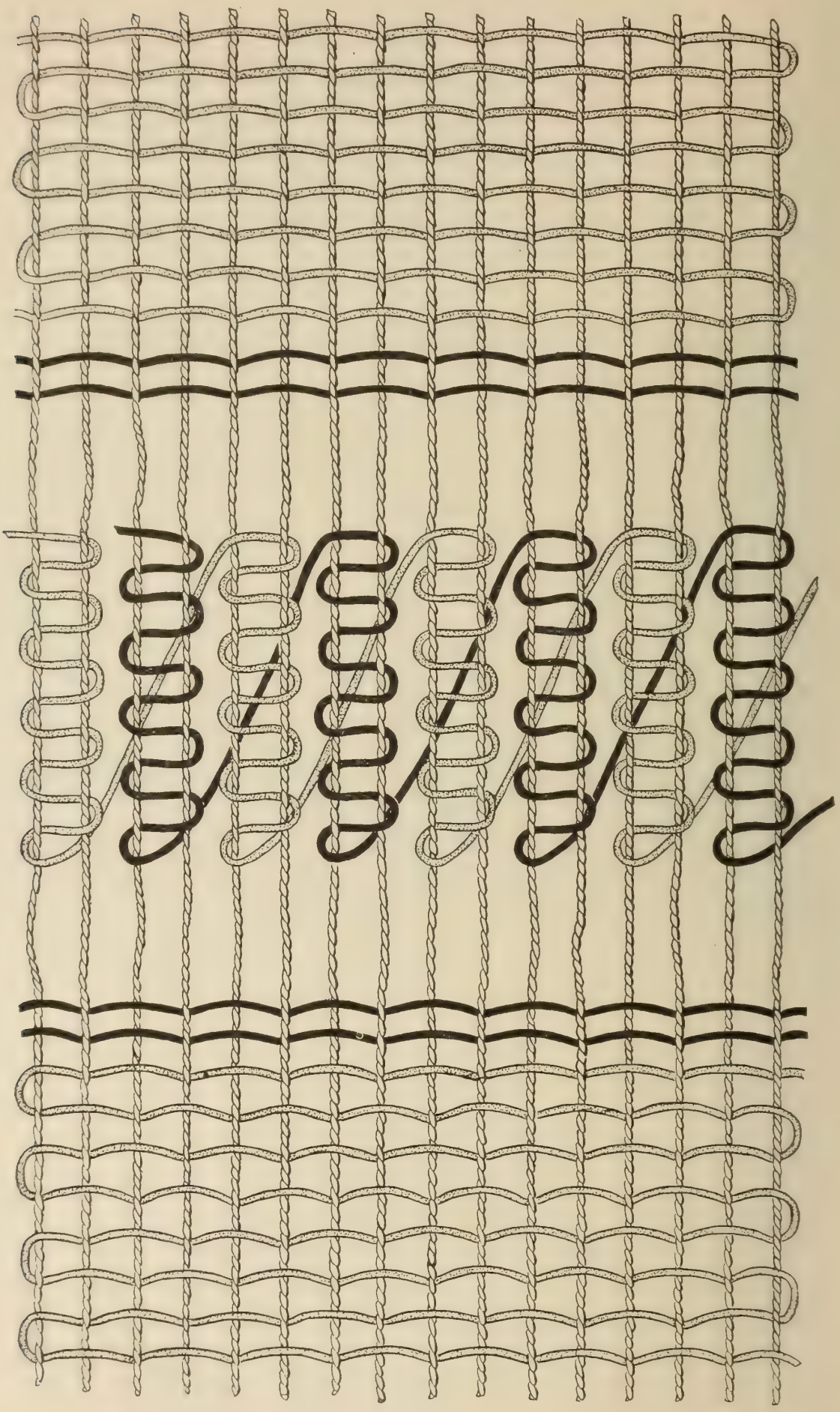

Fig. 2 (B–811). Method of making a Leno Stripe in Tapestry.

therefore, no great class of people engaged in this craft from which the French Government can draw the most skilful and most rapid artisans for even a subsidized industry. In Peru almost every woman was a textile worker, thoroughly understanding every detail, and no doubt the most skilful of these were elected to serve in the convents which were in a sense great textile institutions. There can be little question that such surroundings greatly increased individual skill, and that these weavers worked with a dexterity and rapidity as amazing in its way as are the wonderful results of their labor. However, it must be freely admitted that under the most favorable conditions the construction of these webs must have taken considerable time.

The theory of tapestry weaving is simplicity itself. It is merely a kind of darning of weft over or under tightly stretched warps. Only one element, the weft, requires manipulation. Once the warps are stretched in the loom they need never be disturbed. Tapestry weaving precedes the most primitive shedding devices. Of course, after the discovery or invention of heald rods, tapestries were woven on looms containing this archaic labor-saving device, but even after this introduction, figured webs were woven without its aid. In fact, the principle involved in tapestry weaving, precedes the loom itself, for when the first savage intertwined pliable boughs with the rigid upright stakes to form a fish weir, the resulting texture was a kind of tapestry, since tapestry is a fabric in which weft crosses over or under equal warp units and is inserted in such a manner as to completely cover warps when beaten up. Today the term is always applied to decorative webs, but as this description can be as well applied to them and also include certain unfigured cloths from Peru, the definition has been limited to mechanical peculiarities.

Design was produced in this class of weave by the contrast of varying colored areas darned on the warp according to the above rule. Therefore, it must be obvious that each field of color, however small, forms in a sense, a separate fabric (Fig. 1). To make the design, as many bobbins of weft were required as there were shades in the design (see tapestry belt loom, this volume, Fig. 13, p. 84). In weaving, the back of the fabric was toward the weaver. She picked up the bobbin containing the shade of weft yarn to cover the first few warps on one side of the loom, laced them in, took a second color, and so on, until the entire width of the warps was covered. Then the same operation was performed from the other side. In this manner, the designs were built up, a pick of weft at a time, not each formed separately and the space between then filled in as in modern Navajo blankets. In the best Peruvian tapestry, the wefts are almost perfectly parallel, however often the color may change. Unless the methods above described

were pursued, this would be impossible. It must be obvious, therefore, that when two areas of color come in contact on parallel warps, there would be a slit in the fabric unless some means were employed to close it up. Sometimes short slits were purposely left open to accentuate design (Fig. 1); sometimes they were avoided by having colors come in contrast on lines running at oblique angles to the warp. The most interesting technique in Peruvian tapestry webs is displayed in the manner in which these char-

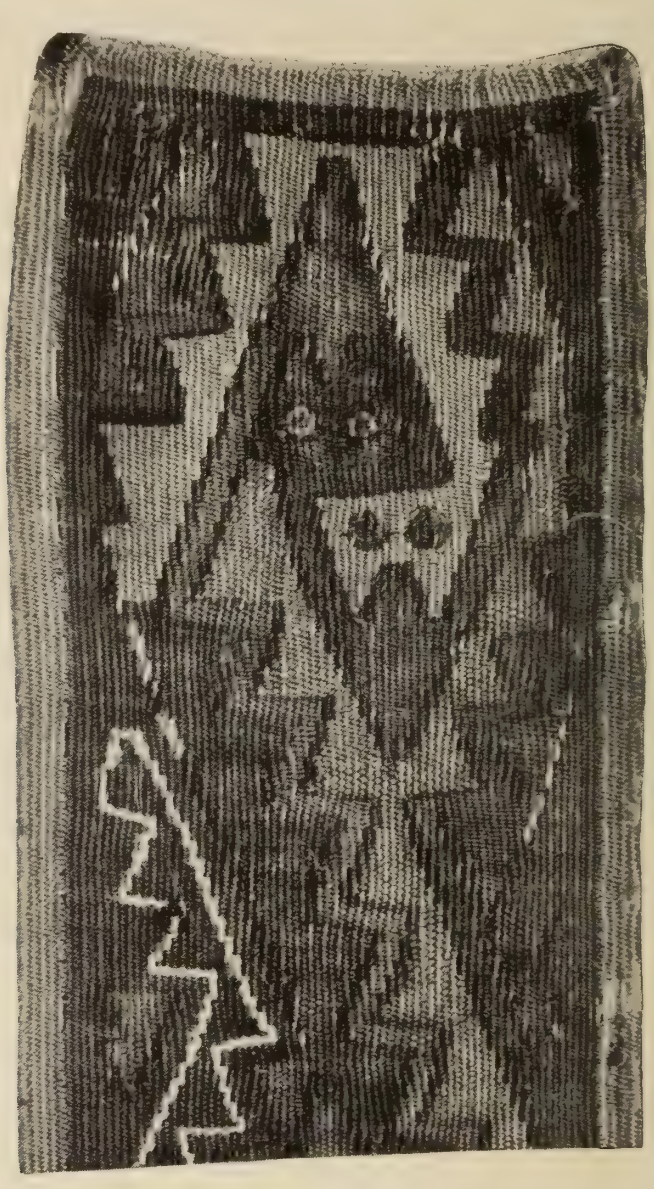

Fig. 3 (B–9650). Portion of a Tapestry Belt.

acteristic slits were closed. I have therefore thought it best to refer to the diagram of this technique in my first paper.

It is as impossible to give an idea of the fineness of these webs, as it is to convey a conception of the beauty of the color combinations. Certain webs are so perfect that it would be impossible to add an extra weft yarn without puckering the cloth. Weaving errors were never detected no mat-

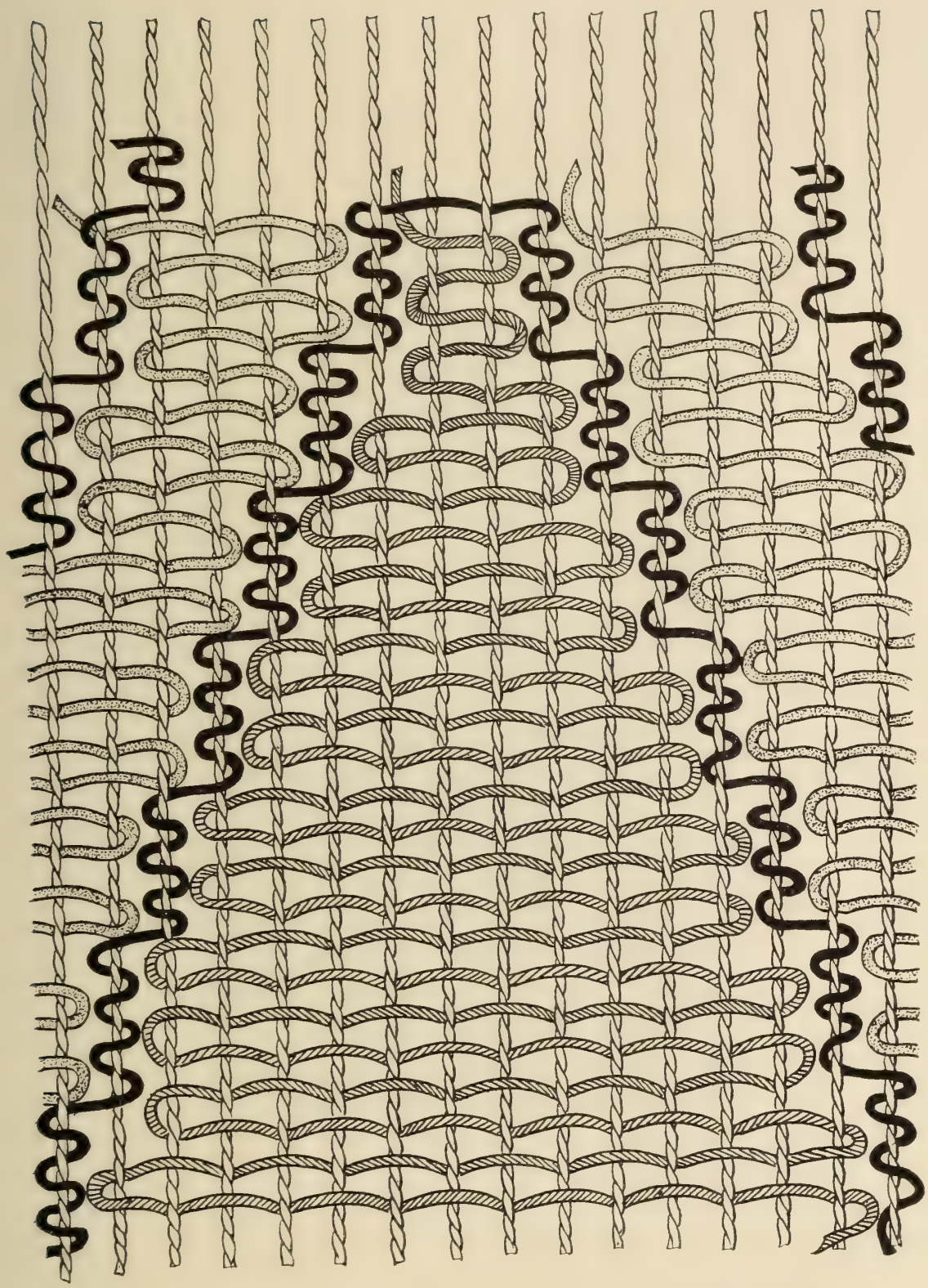

Fig. 4 (B–9650). Method of outlining the Figures with Black Weft wrapped around the Warp.

ter how complicated the design, each square inch was found to contain the same number of warp and weft. Mention has been made of the use of bobbins in weaving. Each color required a separate bobbin. When this color was not needed in a certain area of the web, it was allowed to rest on the stretched warps. When it was again required, it was carried to the next area to be covered. Certain fragments of webs in the collection show these loose hanging threads connecting areas of the same shade or

Fig. 5 (41.0–1152). Tapestry from Nazca in which all Wefts interlock.

color. But in most fabrics these ends have been cut off and so carefully tucked in that it is impossible to determine which is the face and which the reverse of the fabric. The backs of the most beautiful Gobelin tapestries are a mass of tangled threads and the slits have been closed, except in the Morris tapestries, by rough sewing. Contrast this with the exquisite care taken in finishing the tapestry of the old Peruvians. In Coptic tapestries

very often borders were taken from one fabric and sewed on another. This was never done in Peru. Occasionally, borders that ran parallel to the warps of the fabric were attached by an extra thread, but never actually sewed on the surface of the fabric. If the Peruvians made a practice of using the borders after the other, less durable parts of the web had been worn out, we might understand their finishing their tapestries on both sides, and also account for their double-faced bobbin-weaves. In the absence of any proof of this, we must attribute this exquisite finish characteristic of the finest webs, to their craft pride. No one can long examine these wonderful fabrics without feeling the sense of beauty and the great degree of skill displayed which raises their best weaving from a craft to the status of an art.

Besides the technical skill shown in closing slits, to which reference has

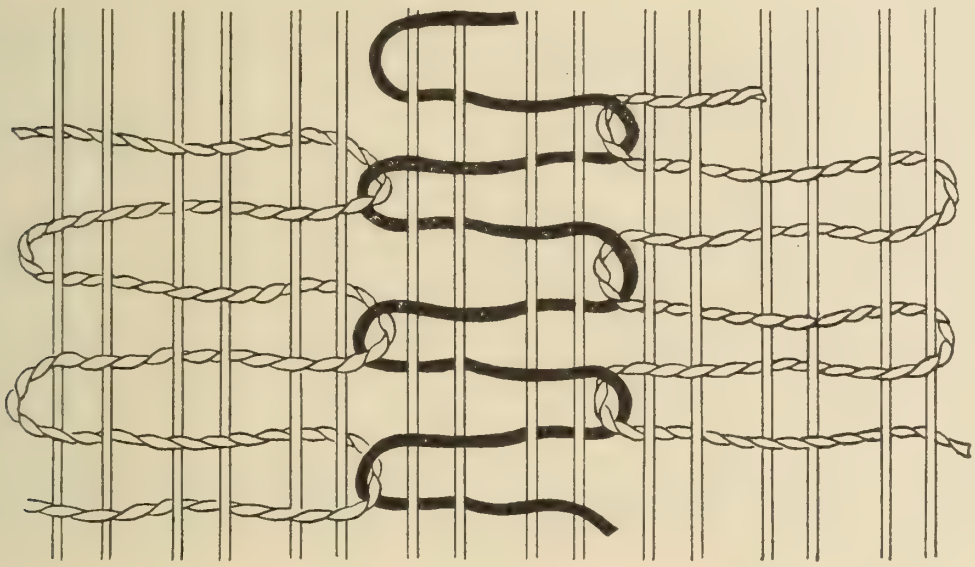

Fig. 6 (41.0–1152). Diagram showing Interlocking Weft.

been made, there are many skilful methods of varying the monotonous effect of their simple weave. Fig. 2 is an example of a leno or open stripe produced in tapestry.

Fig. 3 is an illustration of a fine tapestry belt. Fig. 4 shows the diagram of the technique. The triangular figures have been outlined by wrapping warps with a colored weft. The diagram represents a small portion of perhaps three-eighths of an inch. A fine example of the wrapped warp technique is in the collection but not illustrated in this paper. This is a beautiful belt, containing a most interesting design in which the pure geometric motives are combined with symbolic figures in a wonderfully balanced color scheme. The black outlines of certain of the units have been formed by the aid of a single intervening warp covered with a black yarn.

Certain tapestries contain examples of eccentric weft, that is, weft that crosses the warps at other than right angles. There is no intention of correcting slight imperfections of texture, but an evident purpose to vary the monotony of this weave. The insertion of this weft occurs between two figures and sometimes as an outline to certain small elements of design. It may have been inserted with a needle.

Besides the filling in of spaces between figures by the needle, there are a few fragments of belts in which almost all the wefts run at oblique angles to the warp. When these fabrics are held up to the light they do not show the transparent outline which commonly appears between other tapestry figures. In Dr. Holmes' monograph on Peruvian tapestries, he comments on this peculiarity. The skilful application of eccentric wefting allows a gradual tapering of the figures so that the slits incidental to contrasting color areas are reduced to a minimum. Even these minute openings were closed where necessary by the aid of actual needle insertion. In these pieces the designs lose their accustomed rectilinear outline and are formed from curved lines on plain, closely woven cloths. Great skill has been shown in inserting the weft, where necessary, at oblique angles to the warp. The resulting fabrics are as solid as plain web.

Figs. 5 and 6 show an unusual refinement in the insertion of weft. Between each color a black weft forming a line in the texture intervenes. The colored weft interlocks with this as in Fig. 6. On an average there are eight such interlockings to the inch and as there are seventy-two weft picks per inch, this makes 576 spots where weft loops together in a square inch.

No large fabrics containing this technique have been discovered. The method of weaving must have been very tedious and possibly there was a deviation from the practice of building up design the width of a pick of weft at a time. That is, the separate units may have been darned in and the slight opening subsequently closed with the needle.

The space devoted to the discussion of the technique of tapestry weaving has been taken merely to indicate the refinement to which the art was carried. All these little expedients whether they had for an objective the perfection of weave as in the skilful closing of slits, or in the warp wrapping and leno stripe, some relief from the monotony of the weave, simply go to prove to what refinement this simple method of textile expression was carried. Perhaps these deviations may have had an added value as suggesting certain other styles of weave. But the great appeal of these fabrics and their chief interest is to art rather than mechanics. They represent the highest form of artistic expression of a people not lacking in a fine appreciation of abstract beauty.

In the varied range of design which runs from the crude delineation of

symbolical creation to the purest form of geometric art, and even where design figures were distorted by the limits of superstition, the color scheme was harmonious. When we approach that phase of their artistic development where the units of design were employed purely as convenient forms for the massing of colors, we find a knowledge of color values as fine as the world has ever seen. Even the finest examples of cashmere shawls and Persian rugs can show no more beautiful color schemes. The mechanical limits of their art denying them a proper expression in the delineation of form, they expressed their artistic powers in the blending of colors. To this as a natural corollary, they added a fine sense of proportion. The

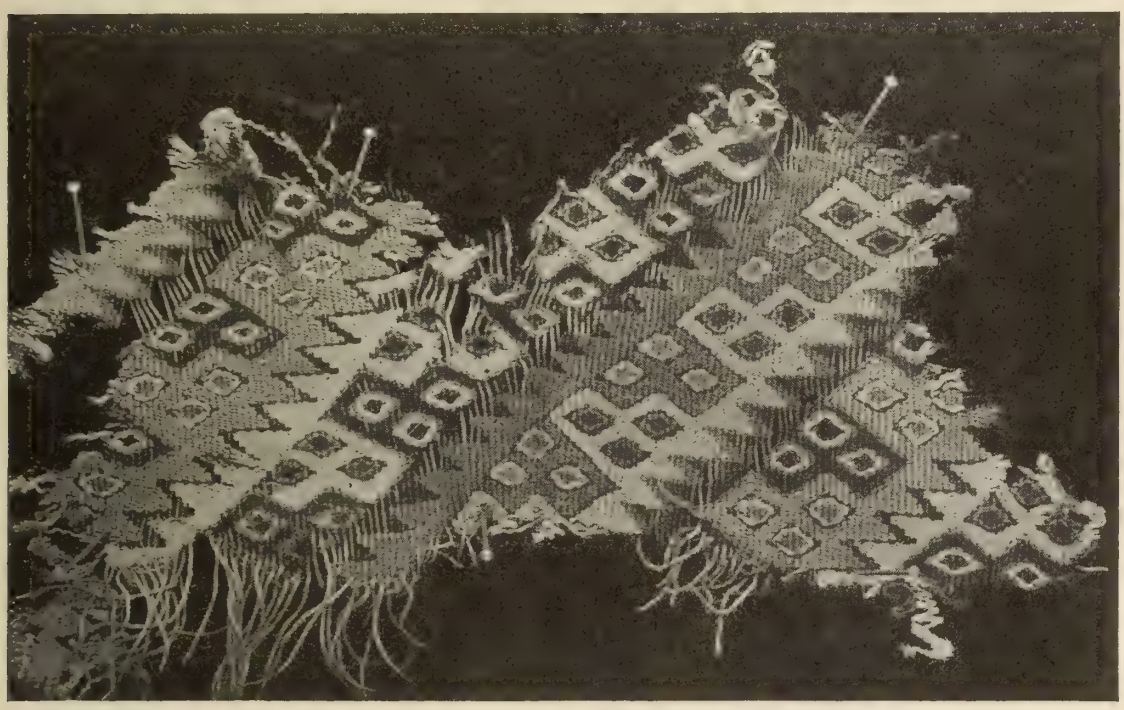

Fig. 7. Tapestry showing the Conventional use of Cat Heads, Pachacamac.

designers of modern textiles, such as upholstery materials, carpets, and hangings, should find in these old fabrics a priceless inspiration. All the arts of decoration, requiring the use of strong colors, might enjoy an equal profit from their study. It would have a unique value as a purely American source of art and give to our industry a certain needed individuality.

The Museum collection contains a number of very beautiful tapestry ponchos. These garments are in almost perfect condition, especially as regards the condition of the dyes. They are well known to most students of archaeology and are illustrated here as examples of two phases of the art development of Peru. The first is an Inca piece, discovered in a stone chest on the island of Titicaca (Fig. 8). Other Inca specimens show not only greater technical skill but a higher art value. This one is typical

of what may be termed primitive textile art. That is, the design has been developed with attention rather to the portrayal of the incidental portions than as a connected scheme of ornamentation. The separate panels are ornamented with animal figures and the border contains a series of human forms of highly martial character. A further interest attaches to the fact that these later figures are partially formed from silver tinsel yarn. These yarns are formed by twisting thin silver ribbons about a core of wool yarn and are the same in character as the tinsel yarn used in the famous Polonaise rugs.

The color scheme, while excellent, is perhaps a trifle strong, while the design plan is distinctly barbarous. In the second poncho, the combination of color and the proportion of design is perfect. This poncho comes from Tiahuanaco and is typical of the best work of pre-Inca Peru (Fig. 9). In texture, it is perhaps not quite as fine as the standard of excellence established by B-1225, but even here the difference is very slight. The proportion between the V-shaped neck piece and the border is perfect. The simplicity, directness, and purity of the geometric figures suggests the love of form of ancient Greece.

The warps of both these pieces are of three-ply cotton and the weft of two-ply vicuña.

I leave the discussion of this class of textiles with extreme reluctance. It is so rich in artistic suggestion and interest as to deserve special consideration, perhaps at some future date. It bears worthy comparison with Coptic and Byzantine workmanship and with the later silk tapestry of China. It is as high in artistic and mechanical merit and more deserving of study since it represents the complete development of a single people and the most comprehensive collection of prehistoric art in existence.

Fig. 8 (B–1500). Inca Poncho found in a Stone Chest on the Island of Titicaca, containing a Border in which Silver Tinsel Yarns occur.

Fig. 9 (B–1506). Tapestry Poncho from Tiahuanaco, perhaps the handsomest fabric in the collection.

BROCADE AND EMBROIDERY.

In the first paper of the series, certain fabrics really brocaded were assumed to be embroidered. This misapprehension was the natural result of the great similarity between the two methods among the ancients. Embroidery is the addition of ornamental yarn or yarns to an already woven fabric. It is inserted by the aid of a needle or needle-like instrument, and need not cross the other yarns at right angles, but may be applied at any angle, at the caprice of the artist. Many fabrics in the collection take full advantage of this freedom. So strong was the influence of the textile art upon this people, that many of the finest embroidered webs voluntarily followed the rectilinear outline produced by the crossing of thread at right angles, despite the liberty inherent in this class of texture.

Brocading is the addition of an extra ornamental weft or wefts, inserted during the actual weaving of the fabric. These decorative units must follow the angular restrictions of the plain weft, and are generally of larger diameter and softer twist and are inserted in a slacker manner, so that the beating up may cause them to cover the warp and weft of the basic fabric. They are generally inserted in such sheds as to cover or go over a much greater number of warps than they go under. One fabric examined contained just twice the number of warps as plain weft and the brocade yarns were caught under every other end. Here was plainly a kind of basic fabric especially woven for this nature of design. In certain fabrics the brocade weft covers unequal warp groups as in bobbin-weave. However, some follow the same sheds as the ordinary weft.

The difficulty of determining which was embroidery resembling brocade and which the true brocade was solved by two partially woven fabrics still in the loom (Fig. 10) which were a part of the collection recently presented to the Museum by Mr. A. D. Juilliard. These fabrics were about a quarter finished and had evidently been buried with their weavers. They contained very intricate designs. Since they still show three-quarters of the warp unpicked, the decoration must have been applied during the formation of the web and they are plainly brocade.

In the light of the facts revealed by these partially woven webs, some rules may be outlined, which will aid in the proper classification of these so nearly allied techniques. However, owing to the great skill of these workers, it was quite possible for them to make embroidery which closely imitated brocade. Therefore, the rules are to be accepted as subject to

qualification. Another confusing detail is the combination of these two styles in a single figure. Bearing these points in mind, the following explanation will be reasonably exact. If the decorative yarns are plainly sewed on, that is, have been carried completely through the fabric, and if stitches are occasionally taken at other than right angles to the warp, it is embroidery. If the decorative yarn runs parallel to the weft of the basic fabric, and therefore at right angles to warp, and if it is only caught under warps, it is brocade. The reverse side of brocade will only show a very faint trace of the surface color where the decorative weft goes under an end of warp. Embroidery sometimes has the same peculiarity, though hardly to such a degree. If the decorated weft is carried from selvage to selvage, it is almost certain to be brocade, although many true brocades are woven in modified medallion form.

This technique is very common in these old fabrics. The diagram shown in Fig. 11 is an expression of unusual refinement in which the very order of shedding warps is made a means of creating design. Fig. 12 shows the actual fabric. In the first paper, this was erroneously referred to as self-decorated embroidery. Examination of the diagram will show that the warp and the basic weft cross over and under each other in the regular order of simple interlacings. But the decorative weft is picked in double and goes over five warp ends, then under one and over five again, each successive pick beginning one warp nearer the left hand selvage, the order is then reversed until a diamond-shaped figure is formed. It will be observed in the illustration that a second figure or concentric diamond is formed by the appearance on the surface of the section of the warps under which the decorative weft is picked.

A similar technique appears in which a very heavy brocade yarn has been used on a comparatively light fabric. The central portion of this shawl-like garment is a light voile-like fabric of cotton. On the diagonal corners brocade decoration appears in which a series of diamond figures have been formed by the raised warps as in the diagram.

The writer is familiar with no other textiles made by hand which contain so manifest an evidence of loom control. A close parallel is found in the tinsel brocade fabrics of Asia which are made on treadle looms. A fine example of this was shown in the recent textile exhibit at the Metropolitan Museum of Art. It must be evident that to accomplish this result a great amount of careful mathematical calculation and great care were indispensable.

The borders of certain Ica shawls display a very skilful technique (Fig. 13). The object has been to obtain a fabric in which the embroidery yarn completely covers the basic fabric. For this purpose a very loose web was

Fig. 10 (41.0–1560). Partially woven Web from Ica, containing Brocaded Design.

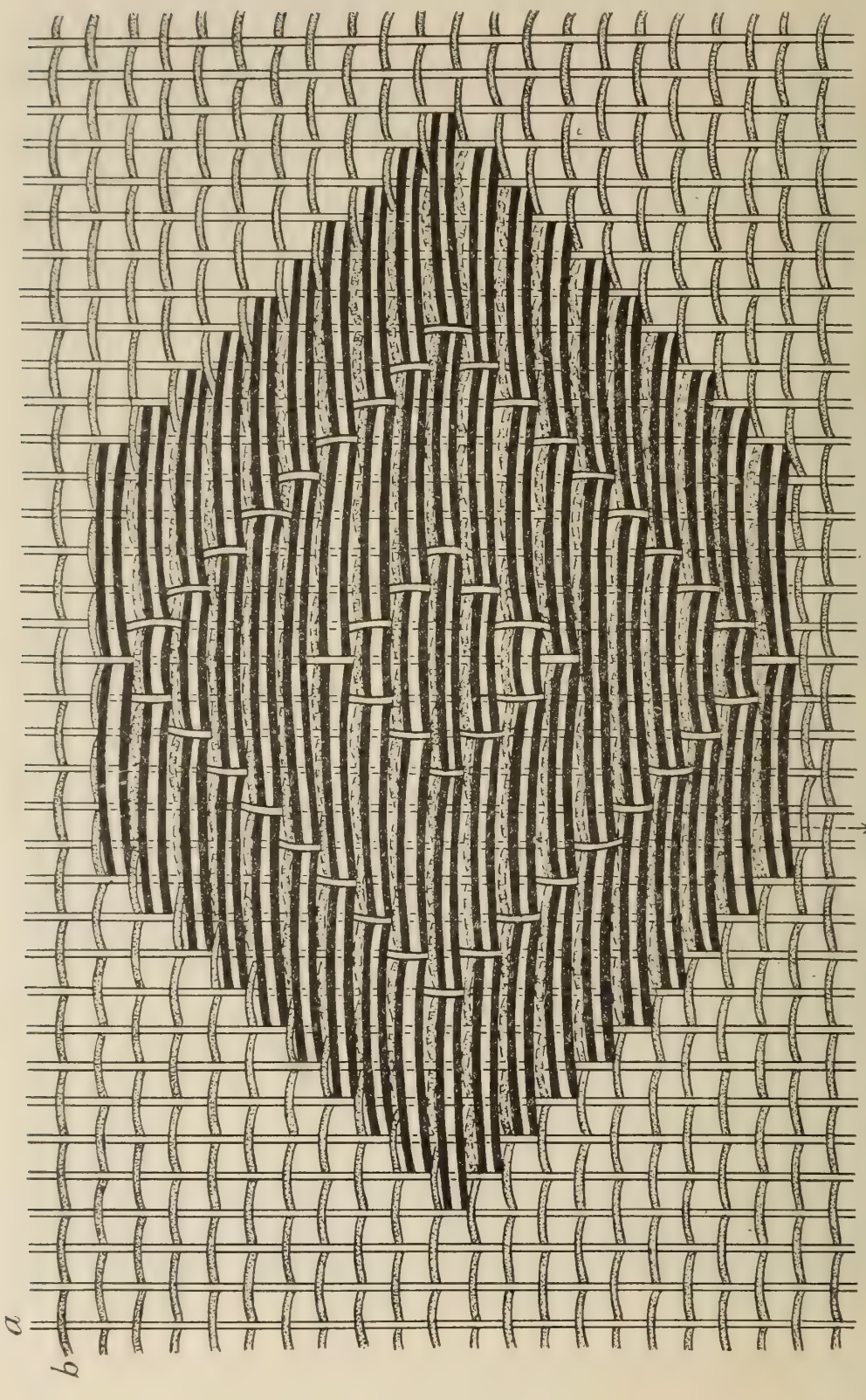

Fig. 11. Brocade in which the order of shedding warps produces an additional design, *a*, warp; *b*, plain weft; *c*, decorative weft. No plain weft can be seen under the decorative weft, but the stippled line shows where it runs under the decoration.

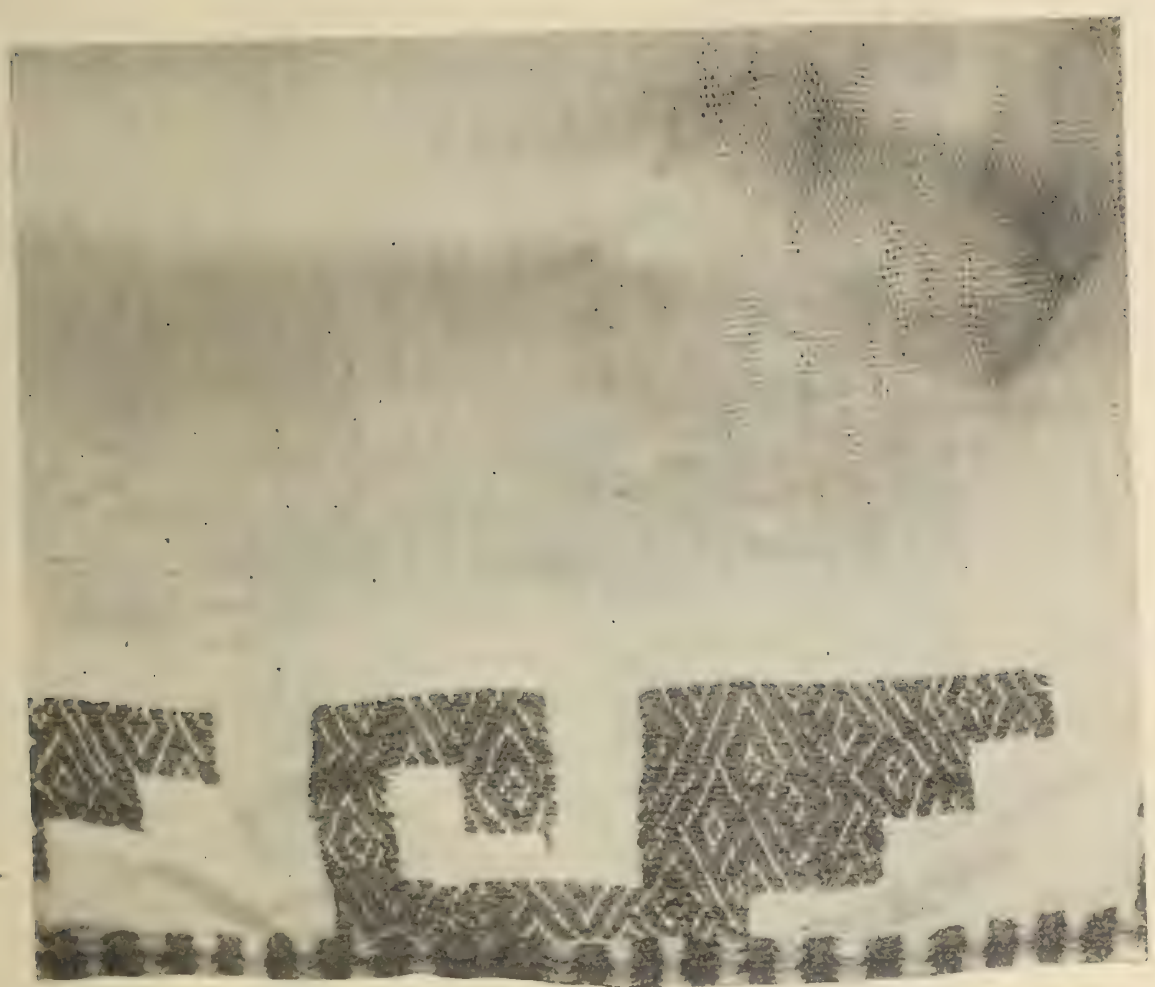

Fig. 12 (B–4334). Brocade Design in which the Order of Shedding the Warps produces a Secondary Design.

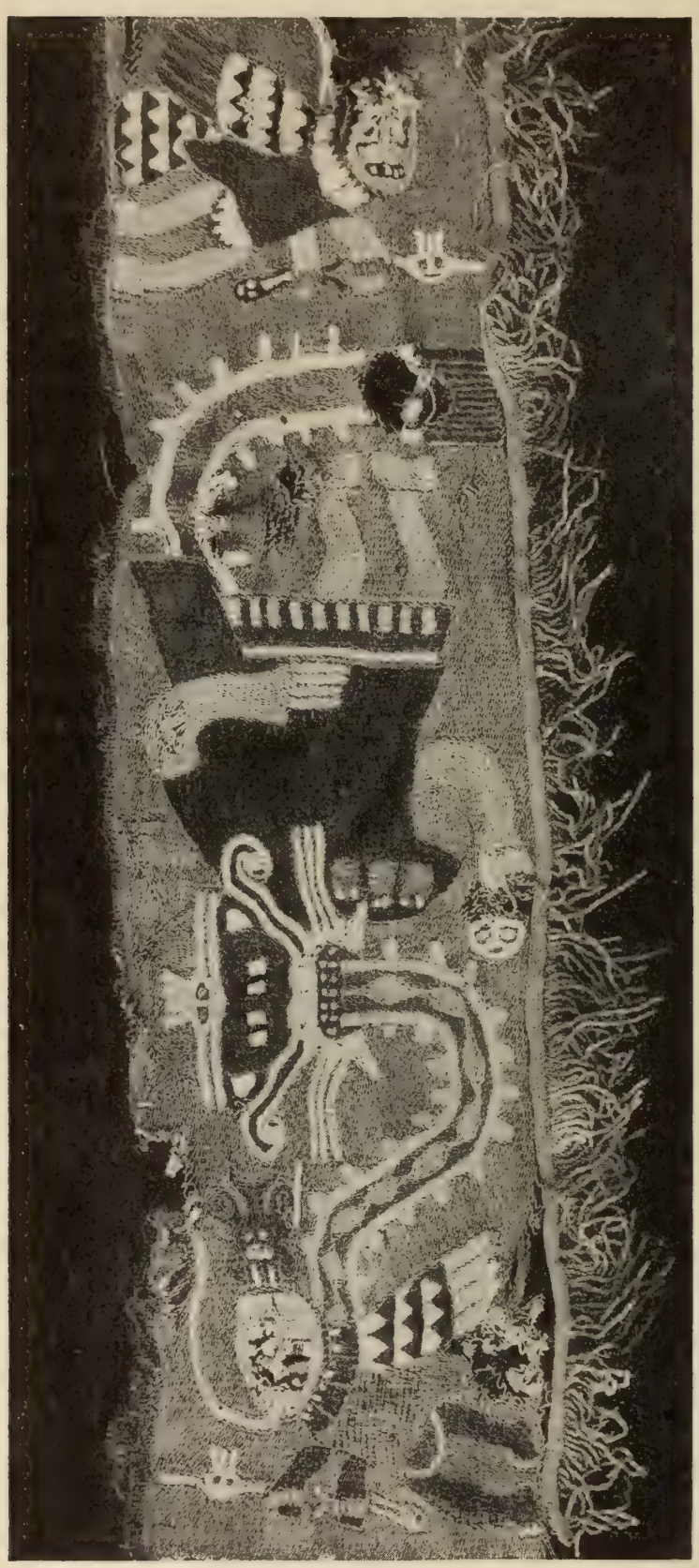

Fig. 13 (41.0–1526). Embroidered Border to Ica Shawl. The embroidered stitch completely covers a very loose basic fabric.

first formed. Apparently the wefts were locked at the selvage into the main part of the shawl. The specimens are so tender as to make this a very delicate matter to be certain of without injuring valuable exhibition pieces. The peculiar way in which the decorative yarn is laced a full turn about pairs of the warp or weft (Fig. 14) forms a ridge-like surface on the back of the cloth. The direction of these ribs changes with the altered direction of the embroidered yarn on the surface of the web. Where this change

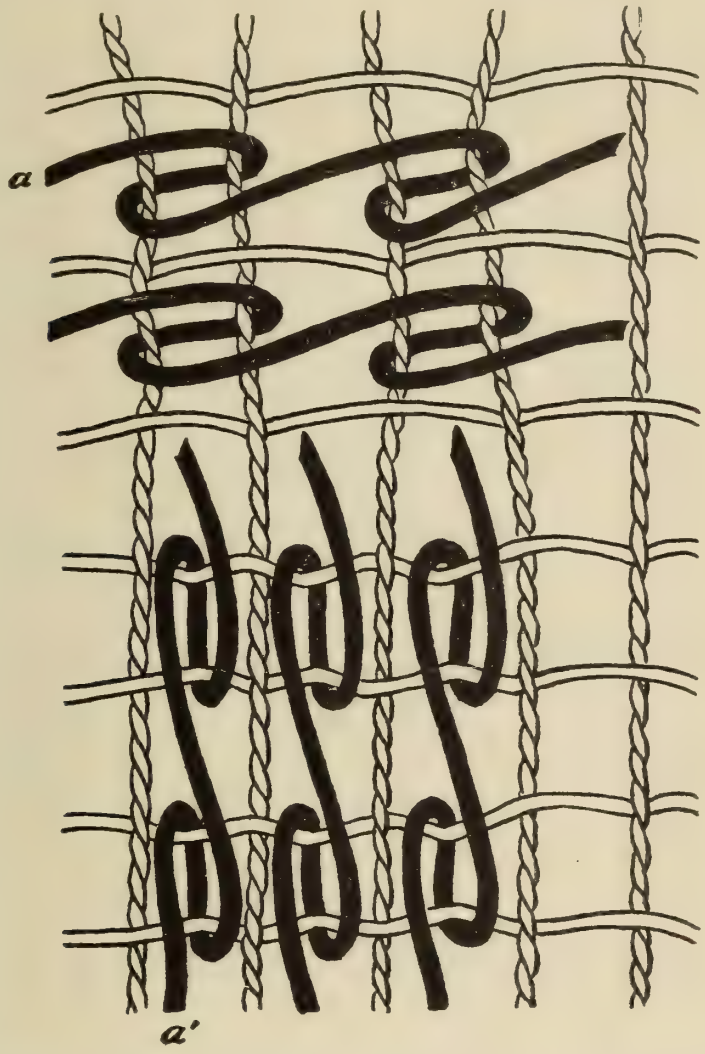

Fig. 14. Diagram of the Technique of Embroidered Ica Shawl showing manner in which Weft is locked around pairs of either Warp or Weft, according to the direction required by the design.

occurs, the embroidery weft has been laced about pairs of warp instead of weft. The looseness of the basic fabric permitted this change to be accomplished by the tightly looped embroidery yarn. A reference to the diagram will at once make this clear. Fig. 15 is an Ica shawl decorated in this manner.

The Ica shawls above referred to contain a combination of both gauze and embroidery. Their discussion has been reserved for the chapter on gauze.

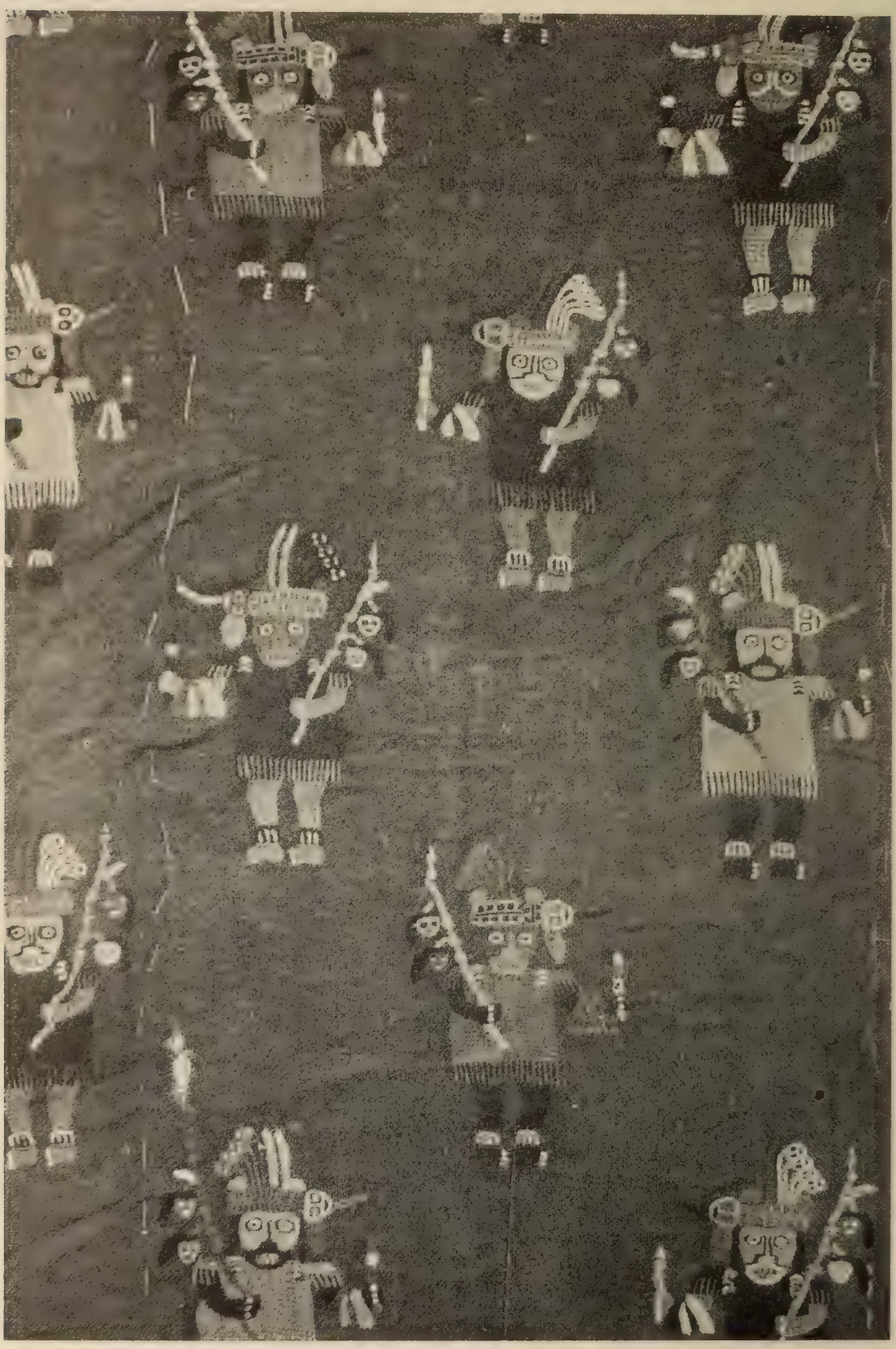

Fig. 15 (B–4334). Panel of Ica Shawl embroidered on Gauze, embroidered Yarn inserted as in Fig. 14.

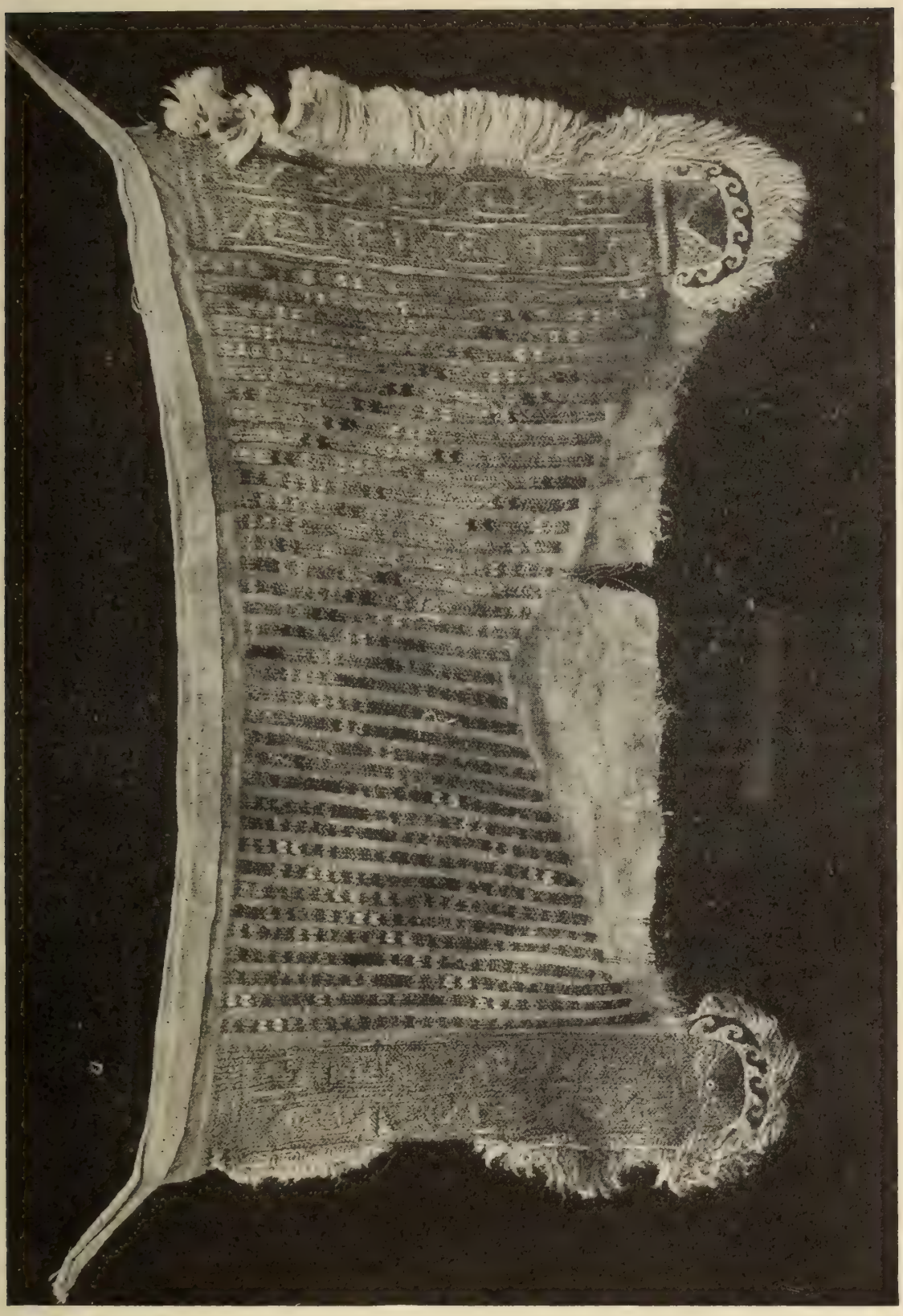

Fig. 16 (B–8685). Chain Stitch Embroidery similar to Moorish Rugs.

Fig. 16 represents an embroidered loin cloth ornamented with chain stitch. The technique is similar to that of Moorish rugs.

In Fig. 17 is shown a remarkable veil. The basic fabric is a very light cotton voile. The yarns are extremely fine and the degree of twist greatly

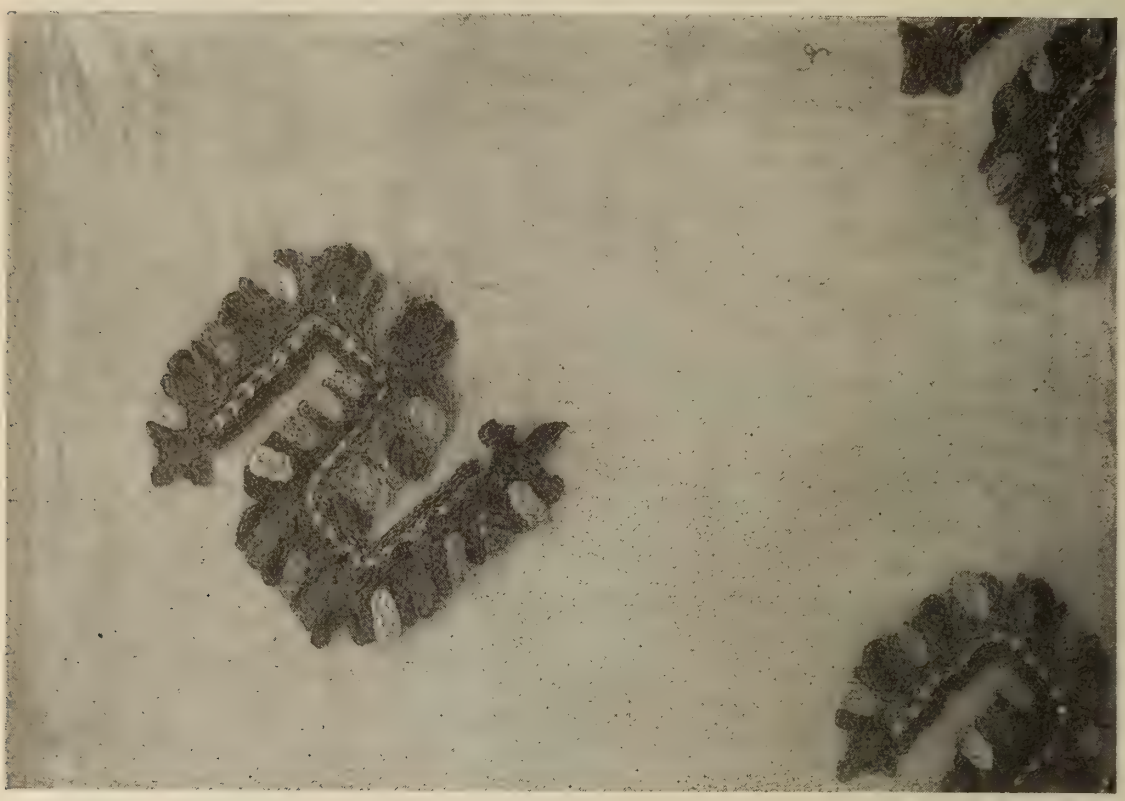

Fig. 17 (B–813). Embroidered Veil.

in excess of modern spinning. The embroidery yarn is two-ply, dyed cotton except the yellow, which is vicuña. The workmanship is superb. The rather heavy figures do not pull the light texture at all. The only other fabrics of this character of a similar fineness and artistic value were the wonderful seventeenth century muslins of Dacca.

DOUBLE CLOTH.

Double cloth or two beam weave, is a fabric containing two sets of warp and two sets of weft which are combined into a single fabric in the loom. Weaving is done on both sides of the loom and at intervals regulated by the nature of the design; certain warps are raised and picked with their weft and the corresponding warps on the surface lowered and picked with their weft. This produces masses of contrasting color on both surfaces, assuming that the two sets of yarns are of different colors. By carefully arranging the order in which this crossing of warps occurred, it was possible to produce almost any design. The designs would be exactly reversed in color; the figures on the reverse side would be the same color as the warp and weft of the surface fabric; the figure on the surface would be the same color as the warp and weft of the reverse fabric.

This technique not only produced design but by the crossing of the two sets of yarn, also locked the separate fabrics into a single web.

It may be that in other parts of the world where double cloth weaving was practised, the object was to obtain a warm, heavy web without the use of coarse yarn, but in Peru no such object was sought. Here this method of design production appears mostly in bags and in the great number of charms buried with the dead where warmth certainly was no consideration. Once its technique was developed this method was actually found to be a very simple means of producing design and for this reason recommended itself to the old weavers.

The fabric selected for illustration is not especially fine in texture, but it represents a very common form of this technique and its open weave and simplicity of design made it easy to analyze (Fig. 18). It is a little charm about $3\frac{3}{4}$ inches long by two inches in width. The central inch and a half consists of a double cloth design of a conventionalized fish. At either end is a narrow length of basket weave in which the two sets of warps appear picked with a single weft. This is not double cloth. Barely enough weft is used in them to hold the fabric together. These ends were folded back of the double cloth and sewed in the form of a small cushion.

The construction of the cloth is as follows (this refers to the double cloth portion): —

Surface fabric warps, 24 two-ply cotton dyed brown, per inch
" " weft, 24 two-ply alpaca dyed red, per inch
Reverse fabric warp, 24 two-ply white cotton, per inch
" " weft, 24 two-ply white cotton, per inch

Basket weave portion: —

48 warps, 24 brown, 24 white, per inch

12 weft, white cotton, per inch

The ends of the fabric appear cut. At the ends of all cloths which are as long as the loom, it is customary to find the warps looped around a loom string. It seems unlikely that the old weavers would set up a fresh warp

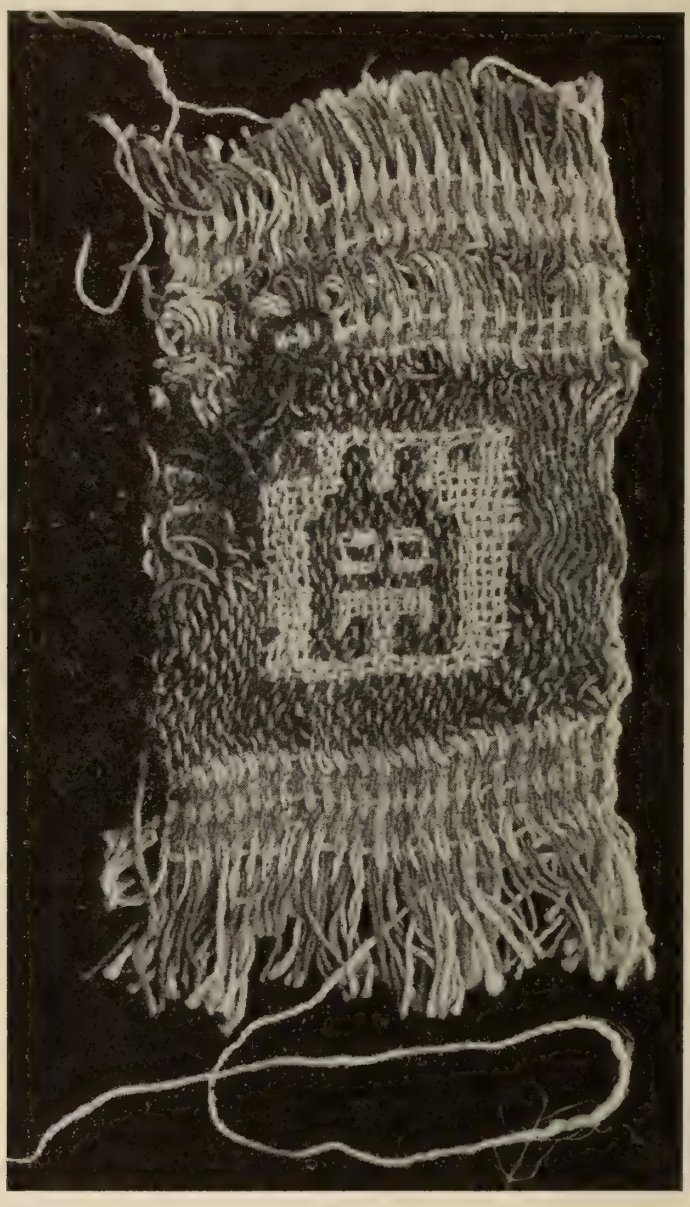

Fig. 18. Small Double Cloth Charm with Fish Head Design.

for such a short fabric, therefore I assume that a number of these charms were woven on a single set of warps. Weft could be changed at any time in the operation. Certain of these interesting objects have double cloth designs on both sides, others have broad weft stripes on the back, but the form illustrated (Fig. 18) is the most common.

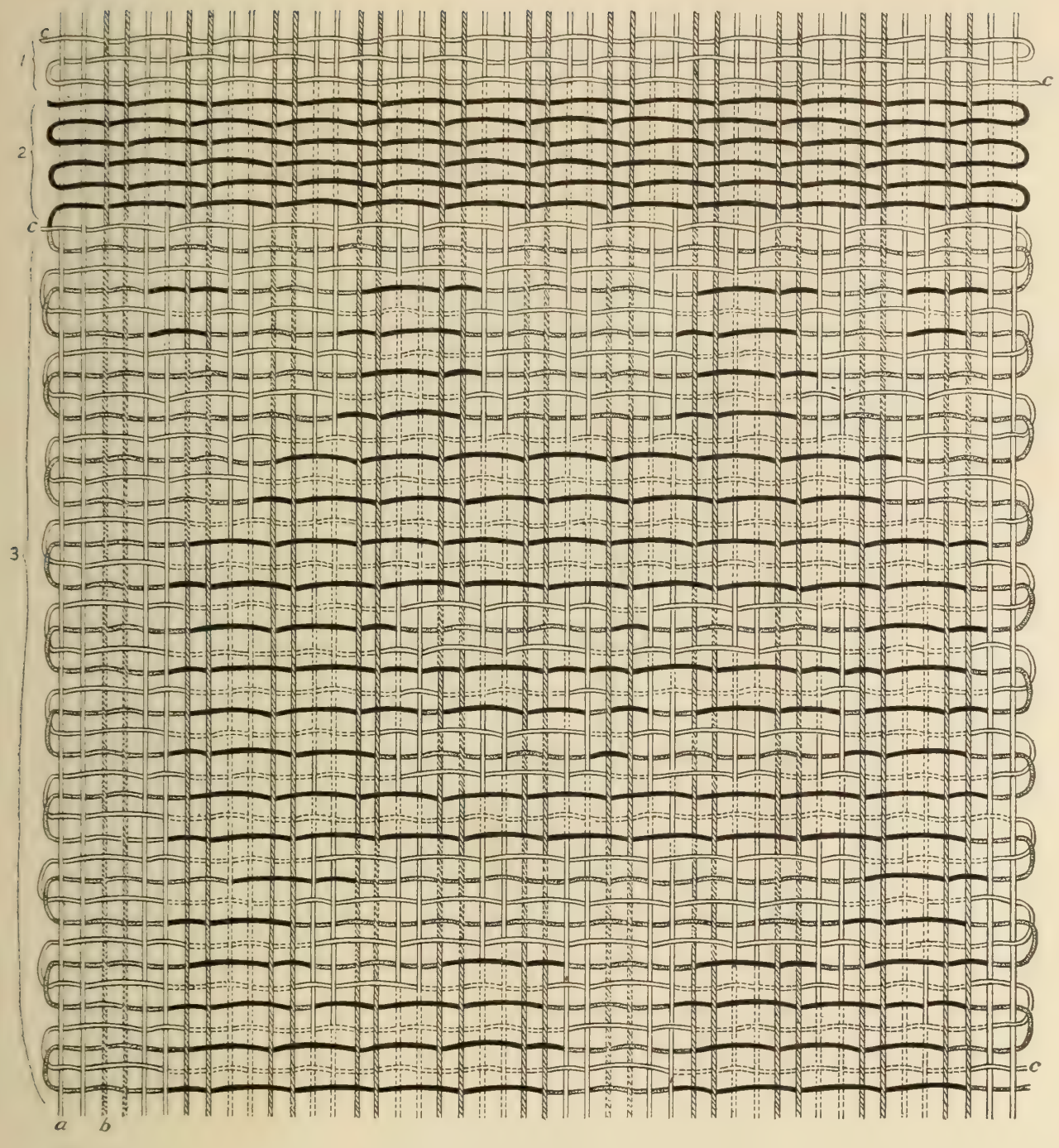

Fig. 19. Diagram of Fish Head Double Cloth Charm shown in Fig. 18.

Let me call the reader's attention to the photograph of the actual cloth. It will be observed that just below and above the white square containing the design there is a broad band of red which ends where the basket weave begins. The diagram shows that the white warps which belong to the reverse fabric are unpicked with weft under this band. This made the fabric pliable for bending at this point.

The diagram (Fig. 19) is divided into three parts: the first includes the basket weave portion; second, that portion which contains a fabric woven from the combination of brown warp and red weft; and third, the portion which is in the area of the double cloth and contains both sets of warp and weft appearing and disappearing as the nature of the design requires.

In number one the warps have been combined in groups of two brown, alternating with two white and picked loosely with a white weft. All the brown warps were raised in one shed, all the white in the alternate shed. The weft has small decorative influence. The method of weaving produced stripes parallel to weft, formed by two colors of warp appearing and disappearing.

Let us now consider the diagram (Fig. 19). In it are indicated four distinct threads. *a* represents white warp. Where this is intended to show on the surface it appears as a plain line. Where it appears on the reverse it is illustrated with dotted lines. *b* represents brown warps; where it occurs on the surface, it is shown by cross hatched lines; on the reverse by dotted lines. *c* represents white weft. When it appears on the surface it is shown by plain lines; on the reverse by dotted lines. *d* represents red weft. On the surface it is shown by a black line, on the reverse by stipling.

Portion one of the fabric has been described. Portion two consists of a plain weave of the brown warps, *b*, with red weft, *d*, for six picks. The white unpicked warps, *a*, hang at the back and are indicated by dotted lines. At the edge of portion three, *b* disappears from the surface, as is indicated by the dotted lines, and *a* and *c* appear for two picks as the change from dotted to solid lines indicates. This change from reverse to surface appearance is quite obvious in the diagram, once the significance of the lines is understood. A continuous repetition of the sequence would be monotonous.

All that it is necessary to understand is that the diagram represents only the white square containing the fish design, the red line over it, and a small fragment of the basket weave which is folded back and sewed when the charm is complete. In the graves, these little cushions often contained bits of cotton, seeds, pebbles, or seaweed.

There is a specimen on exhibition, much finer, both artistically and technically. The design is a Greek fret and in each space surrounded by

the hook are conventional cat-like figures alternating in colors. The narrow border resembles the graceful Hellenic meander. If the symbolical feline were removed, the entire design might have appeared on a vase dug up in the Aegean Islands. If such had been its origin, it would long since have served as an example of the love of beauty supposed to be peculiar to that portion of the globe. Two shades of brown were used, both dyed cotton. Each fabric contains 40 warp and 40 weft per inch or 160 picks and ends to the square inch of double cloth. The yarns are two-ply and, needless to say, very well spun.

Fig. 20 is the finest technical example of this class in the Museum's

Fig. 20 (B–4600). Finest Example of Double Cloth Technique in the Collection.

collection. It is a medium-sized coca leaf bag. The yarns are two-ply cotton, very well spun. The colors are white and brown and the designs composed of a series of small geometric figures arranged in a pleasing manner. There are 48 warp and 48 weft in each fabric, or 192 picks and ends to the square inch.

It is natural to expect to find on this kind of loom at least four heald rods: two for the warps of the surface fabric and two for the warps of the

reverse fabric. However, this is not indispensable, as pointed out in my first paper, as shedding, especially in the coarser fabrics, could be done with the weave dagger aided by the round bits of cane so often found with the buried looms. Their functions, it will be remembered were to keep the repeating sheds when once formed, intact, so as to avoid needless recounting of warp groups by the weaver.

B-4541 is one of those composite fabrics decorated with two or more distinct methods of textile ornamentation so common in fabrics from this country. The upper portion consists of broad brown and white stripes. The lower portion consists of a double cloth, in which the warps in the stripes become the warps in the separate fabrics. In order to make the stripes very distinct the warps are in groups of two and a very fine single-ply cotton weft (about No. 150) is used. When the double cloth section is reached the warps are still treated in units of two, but a larger single weft is used.

Generalities are very dangerous when applied to an art so ancient and so complex as textiles, but the temptation to speculate on the origin of this ingenious technique is too strong to be altogether resisted. The writer's lack of sufficient knowledge of basketry permits him only to suggest that many if not all weaving tricks originated in this interesting craft. Certainly a sufficiently large number of examples might be cited to form a basis for such a theory.

Putting this question aside for the time being, it is certain that some forms of textiles naturally suggest others to skilful weavers. Perhaps the desire to produce tapestry effects led to much of this innovation. One feature of tapestry is that design is formed by combining solid color figures. The use of colored warps and wefts in making plaids soon resulted in combinations of the same shades of these two elements in order to form solid masses of color as an adjunct to design. The white lozenges formed by an application of double cloth weave in Fig. 35 are an example of this. From the occasional use of such a technique as an aid to decoration, to its application throughout an entire web, is not a difficult mental development to follow. So it can be safely assumed that the use of colored warps and wefts in plain ginghams led to the complicated weaving of double cloth.

Double cloth technique has a rather wide distribution. It is very common and highly developed among the Huichol. There is evidence of its existence among the prehistoric Cliff-Dwellers of the Southwest and also a possible reference to its application by the old Choctaw. A few very rare Navajo blankets are thus woven.

GAUZE.

The name gauze was derived from an Asiatic city to which this weave was supposed to be peculiar. Fabrics of this class are today often referred to as lace-cloth; that is, they are woven fabrics which resemble lace. Perhaps the old weavers had this in mind when the technique was invented; a rapid way to produce a substitute for the tedious knitting of the former. However this may be, it afforded them a method of making a light, open web which was very desirable in a hot climate and the peculiar technique locked warp and weft in open meshes that would not pull.

This fabric is woven on modern looms by the use of a half or doup heddle in addition to the other harnesses; but its construction on a hand loom required no special attachment. The principle of gauze weaving is that adjoining warps or groups of warps are twisted one half turn about each other and the crosses made secure by the insertion of a weft pick or picks. If this order maintains throughout, the result will be a plain gauze as illustrated in Fig. 21. It will be observed in the diagram (Fig. 21) that the warps contained in each gauze pair are differently shaded. This does not denote different colors or material, but explains the nature of the half turn.

In Peru this technique was carried to a remarkable degree of complexity. Not only were plain gauzes of great fineness and most excellent workmanship woven, but by skilful modifications many fancy webs were constructed. Fig. 22 shows how warp stripes have been incorporated in such a fabric, by twisting together three pairs of warps at stated intervals. Weft stripes were made by omitting the gauze technique for sixteen picks of weft and picking this portion in the ordinary manner (Fig. 22b).

Fig. 23 is a fancy lace-like fabric, either a shawl or veil in which design has been produced by varying the warp groups which are subjected to the gauze turns. The photograph shows a simple geometric figure and also in one corner the conventionalized figure of a cat.

A very ancient form of embroidery still practised among the Italian peasants has gauze for a basic fabric. It is known as *buratto*. Gauze makes an ideal cloth for this purpose, since the weave is composed of even and open squares, which permit the decorative yarn to be easily applied and each stitch to be of about equal length. There is a poncho on exhibition in the Museum which has a narrow border of gauze containing embroidered design which is so even as to suggest tapestry. The gauze twist may be seen in the diagonal spaces between the figures.

In each part of Peru so far investigated nearly all types of weave appear, but in every locality some particular class predominates. This is quite natural and a similar condition exists today among the hand weavers of the Orient. A recent addition to the Museum collection acquired through the generosity of Mr. A. D. Juilliard exhibits a very remarkable degree of skill in *buratto* embroidery (Fig. 25). Fig. 24 shows a diagram of the gauze basis of this technique. A part of this collection consists of nine

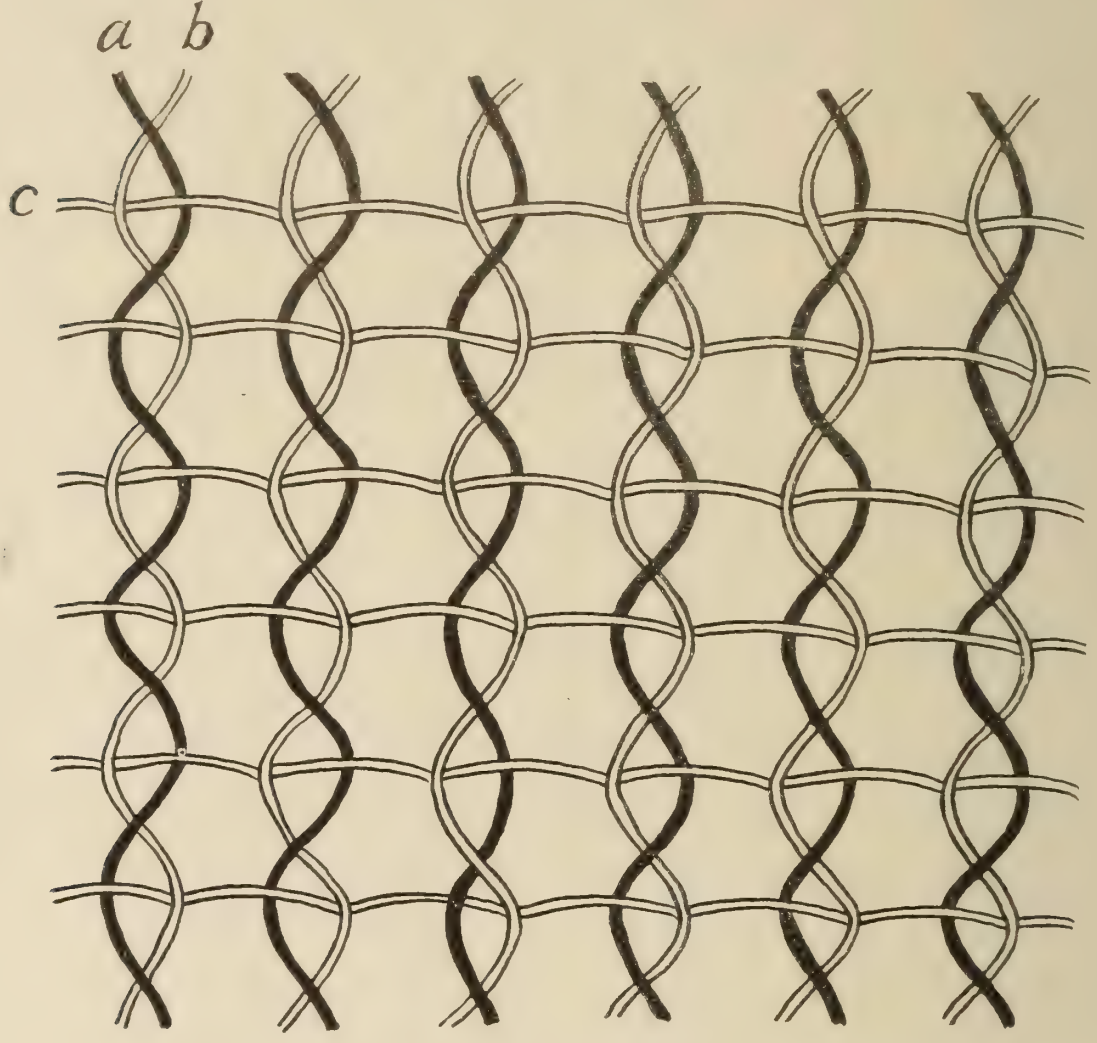

Fig. 21. Plain Gauze Technique: *a*, one warp; *b*, alternate warp; *c*, weft.

large shawl-like garments from Ica, Peru, in almost perfect condition. They are covered with a repetition of one figure in varying and beautiful color combinations. Between these figures a plain, rather loose, woven fabric of wool appears. The figures themselves completely cover the portion of fabric on which they appear, but in a few places age has destroyed the colored yarns, and under the embroidery, the plain weave has been changed to gauze. This accounts for the evenness of the stitches and for the ease with which this is maintained, regardless of what angle the

needle had to go. Reference to the diagram will show this quite plainly (Fig. 24).

No doubt the method of weaving gauze on a hand loom lay in twisting the warps with the aid of the spindle point. As mentioned above, this is very simple. How such an idea occurred is not quite so obvious. Of all

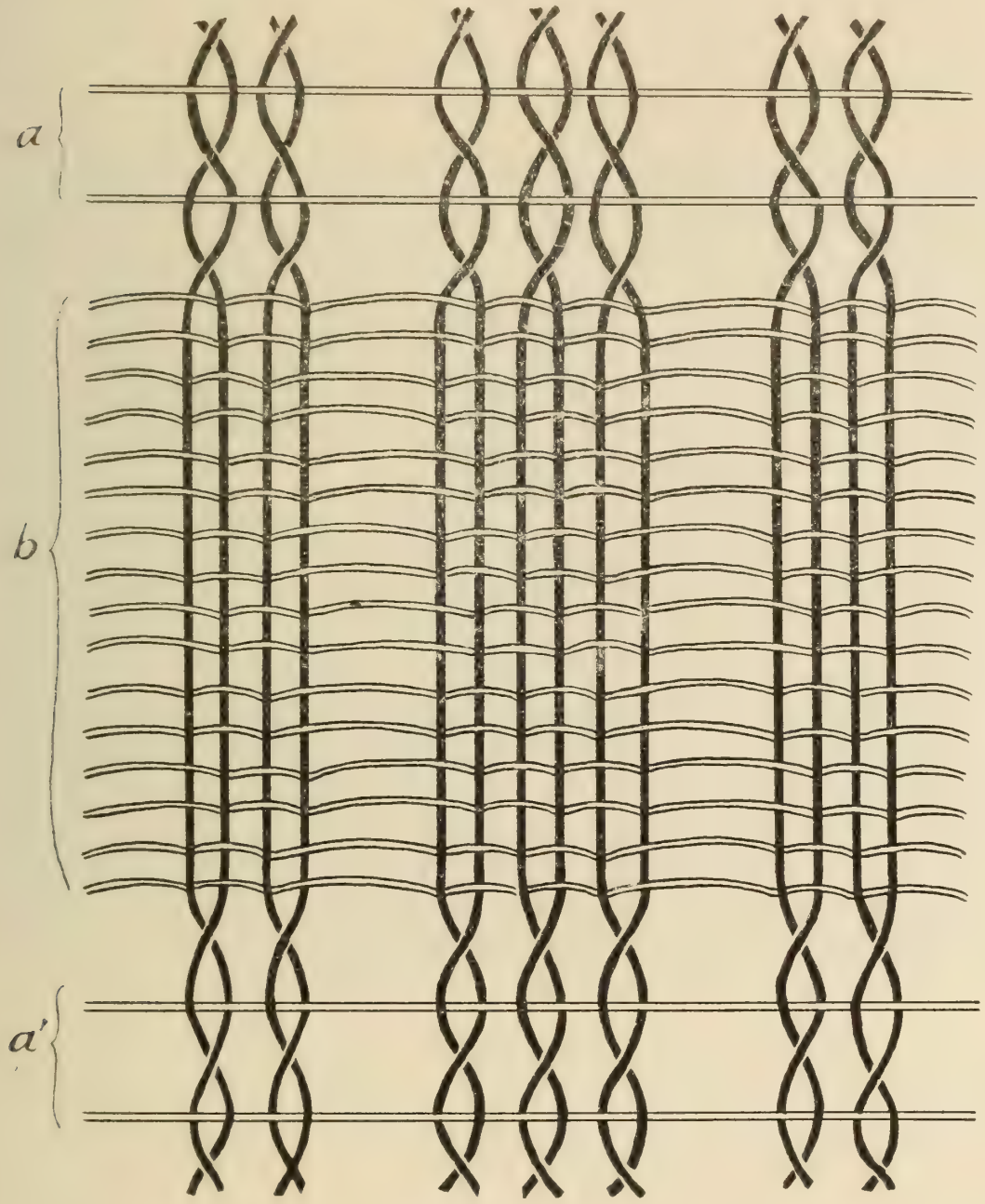

Fig. 22 (B–4336). Gauze containing Stripes, both in Warp and Weft, very similar to a modern technique.

fabrics, except possibly bobbin-weave, this was the last one would expect to find originating on so simple a loom. These techniques seemed so well adapted to the peculiarities of a treadle loom, that this origin was never suspected as coming from the more primitive loom.

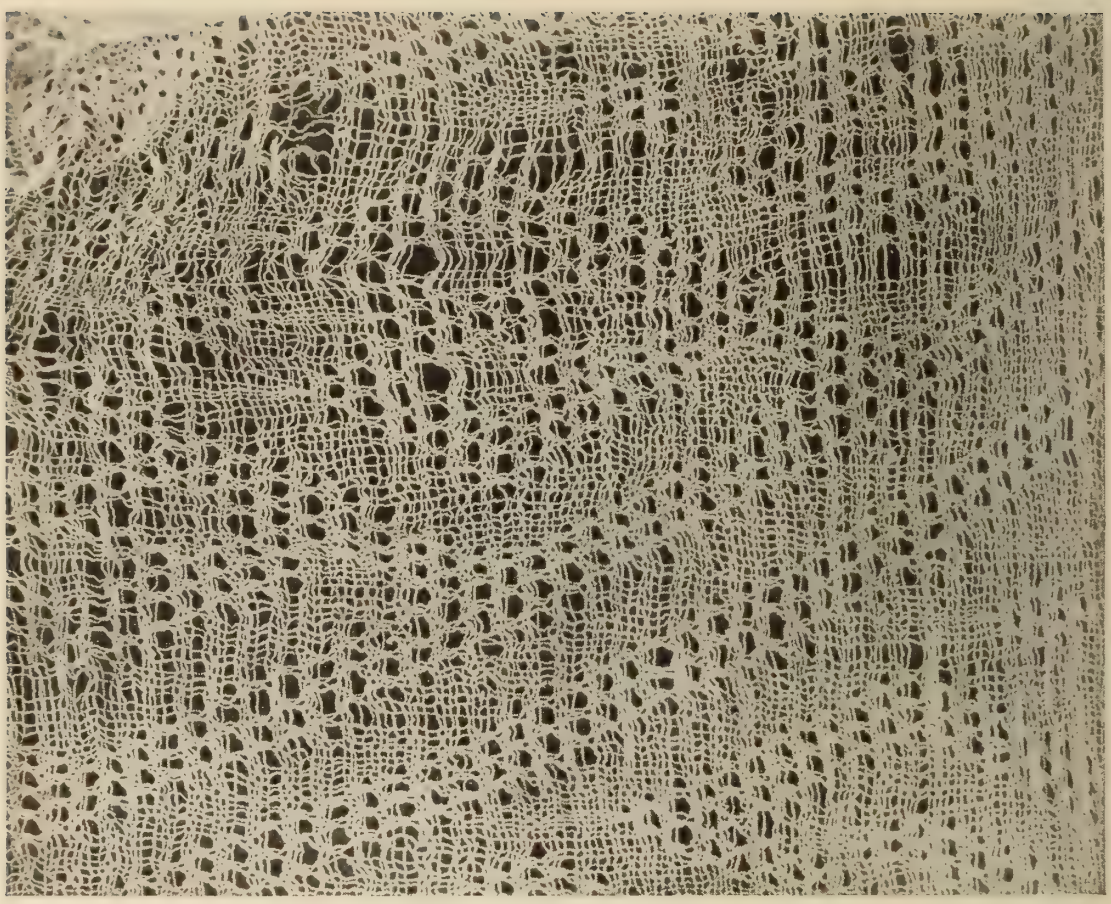

Fig. 23 (B–4070). Figured Gauze in which the Design is created by arranging new Groups of Warps in the Gauze Technique.

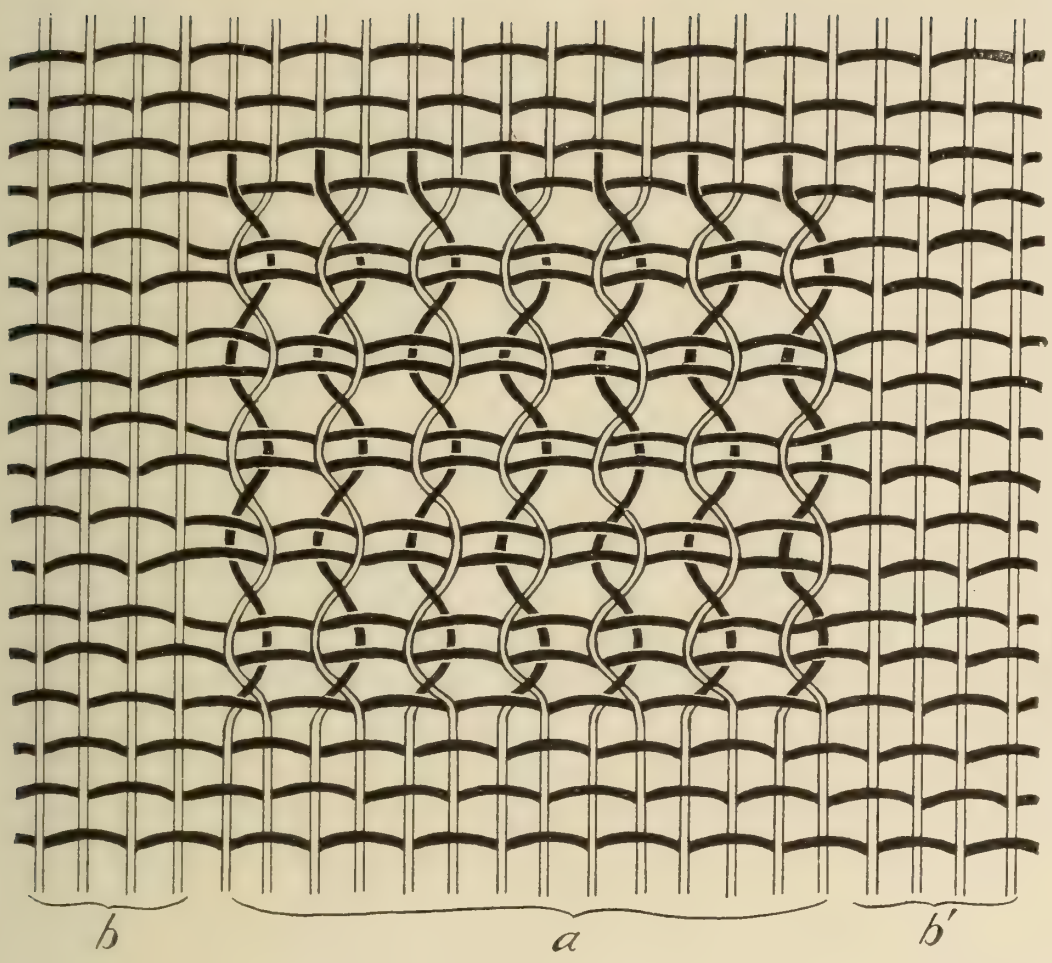

Fig. 24. Technique of Basis for Embroidery of Ica Shawls. This differs somewhat from the border shown in Fig. 15 as in that the basis of the embroidery is a gauze technique. *a*, area in which the plain weave changes to gauze; *b*, *b*,′ plain weave of the fabric outside of the embroidered area. The gauze area is completely covered by the decorative yarn.

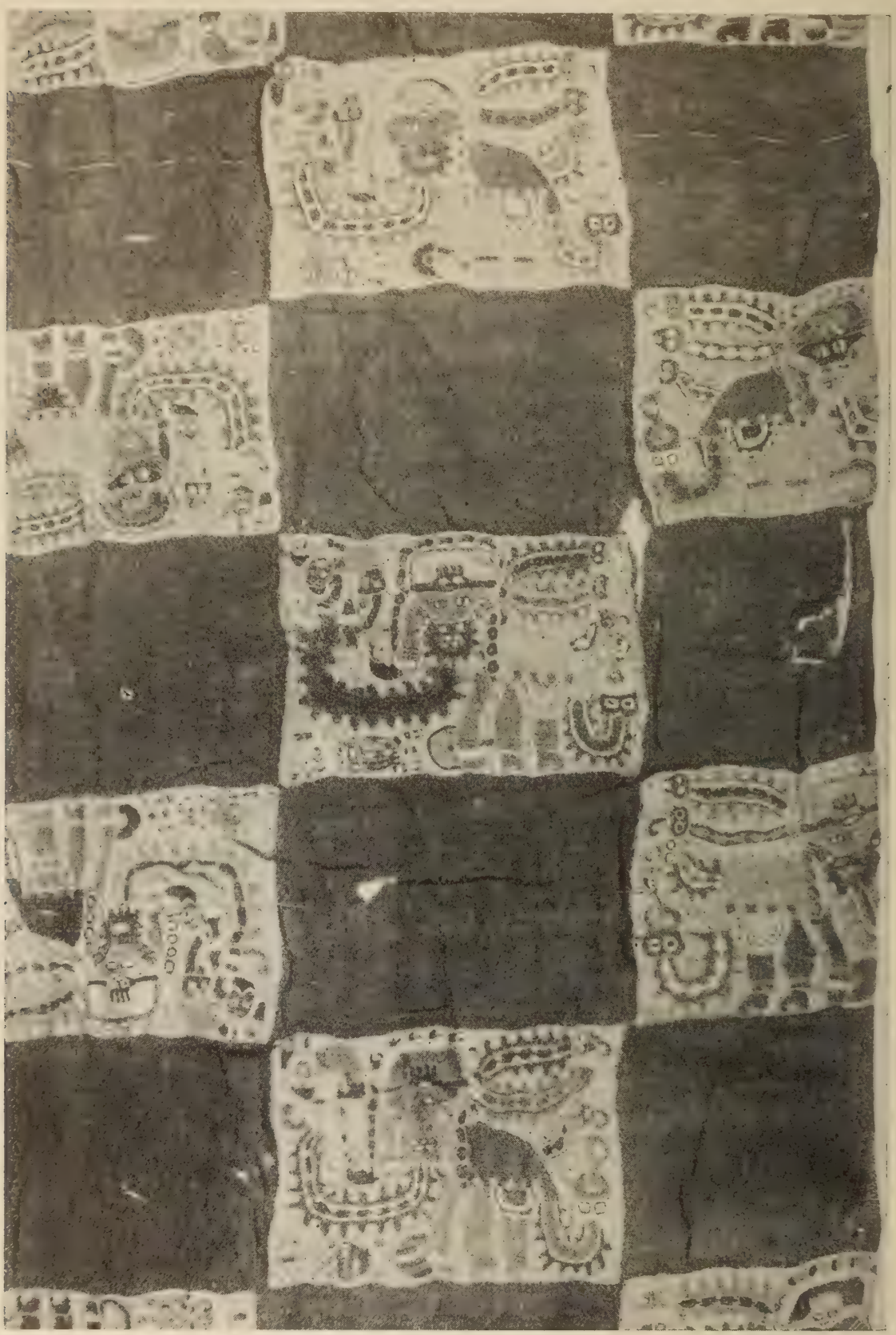

Fig. 25 (41.0–1507). Embroidered Shawl in which a single Unit of Design is repeated in varying color combinations. The undecorated part of the shawl is a plain weave, but the embroidered figures have a basic fabric of gauze as is shown in Fig. 24.

BOBBIN-WEAVE OR TRUE FANCY WEAVING.

The term bobbin-weave was adopted in my first paper to distinguish this method from other Peruvian techniques rather than to give a clear idea of its relation to textiles in general. It resembles modern Jacquard figuring from the fact that the weft crosses through irregular sheds, or over and under arbitrary groups of warp to produce design. In this respect it differs from tapestry where the sheds are always equal. In another and more important detail it differs from figured tapestry in that each color of weft appearing and disappearing necessarily makes the complete traverse of the entire warp. At least two colors are required in this style of weaving. Design depending on the proportion of each color appears in a given area. In some fabrics so decorated a certain design was repeated in squares or oblongs across the warp, but in varying color combinations. Where the colors changed, the new weft was looped into the old. This is only an apparent exception to the rule of a continuous weft as each looped weft may be regarded technically as continuous, or better, each combination of color as a separate fabric. Its similarity to tapestry lies in the fact that weft was inserted in a slack manner which allowed for a beating up as close as in tapestry and which in the finer pieces completely covers up warp. It will be recalled that it owes its name to the assumption that the tapestry bobbin was the implement used to insert weft (this volume, p. 88).

There are two distinct types of this method of decoration found in Peru. In the simpler, rougher method, the weft was inserted with the idea of producing design on the surface only. See border of bird design in Fig. 35. The reverse was a jumble of loose hanging yarns forming no clear design. The weaver caused it to appear when design was required on the surface and then carried it across the unpicked warp until design again called for its appearance. Individual skill is as evident in this as other techniques. Specimens vary in this respect from coarse fabrics up to those possessing considerable technical and artistic merit. In neither particular, however, does it equal the class about to be considered. In this class of technique appear some of the finest of Peruvian fabrics, second only in design, workmanship, and grade of yarn to their most exquisite tapestries.

Both sides of these fabrics are finished. The same design appears on the surface as on the back, except that the proportion of the colors is exactly reversed. This description would seem to fit double cloth, but the most cursory examination will show that unlike double cloth, these fabrics

have only a single set of warps and that weft interlaces with equal groups of warp.

B-5917 was the example chosen for diagram (Fig. 26). It is an intermediate specimen as far as fineness goes, but the marked contrast of color and clear design outline made it excellent for illustration and the comparatively small number of picks and ends made its analysis more certain. The method of determining its structure was as follows: The warp and weft were counted with a testing glass; the nature of the fiber determined with a microscope. Then the weft was carefully cut between two warps, for the distance of about half an inch at the end of the figure to be diagrammed. Lines were then drawn indicating the number of warps covered, and as each pick of weft was carefully withdrawn, its position over and under the warps was carefully noted. The diagram illustrates this exactly and shows the combination of warp and weft necessary to produce one of the bird figures in the photograph. It would be quite possible to show this design in a modern mill draft except that weft is picked much slacker than possible on a power loom and for this reason warp does not show.

This fabric was the border to a plain woven fabric, three warps of which were combined to form one warp for the border. In the diagram (Fig. 27) the warps are drawn as single, for clearness. There are two narrow stripes of blue separated by one of brown tapestry weave at top and bottom of the wide bobbin-weave band. These served the purpose of decoration and also to separate the warps into groups of three for the easy insertion of the bobbin. There are sixteen of these groups of warps in an inch, making 46 per inch of singles. They are single-ply cotton and untwisted; that is, lie parallel to each other, not as a ply yarn. There are 38 weft per inch of two-ply alpaca. The colors are red and yellow.

Referring to the diagram it will be observed that, reading from left to right, the red weft appears on the surface in the following order: over one, under three, over two, under one, over two, under one, over one, under three. The second line representing the yellow weft appears as follows: under one, over three, under two, over one, under two, over one, under one, over three. Carefully comparing the lines in the diagram, it will be apparent that the second is the exact reverse of the first. In other words, where one appears on the surface, the other shows for the same number of warps on the reverse. If the diagram is followed all the way through, it will be seen that this order is the same throughout; the lower pick is always just the reverse of the one above it. This accounts for the design being the same on both sides, and the colors, the exact opposite.

It will be observed in the diagram (Fig. 27) that weft never appears on the surface over a longer distance than three warps. This keeps well within

the rule for good weaving, which in extreme cases allows weft to go over five warp ends without going under one. Greater distances would have a tendency to cause loose weaving. In a number of specimens examined, the writer has observed no exception to this rule.

B-9637 is a piece of tapestry containing three stripes of bobbin-weave figures, one represents two cats in yellow and red, a second represents the same figures in red and blue, and the third is the interesting stripe. Origi-

Fig. 26 (B–5917). Double-faced Bobbin-Weave Border.

nally, this stripe contained the same figures as the other two. The color combination was a fine shade of heliotrope and some other color which is almost completely rotted away, leaving the bare warps which it should have covered, to form design. The vanished color may have been a dark purple or brown.

The border of B-4319 is an example of single-faced bobbin-weave. The illustration (Fig. 35) plainly shows that the weaver paid no attention to

the production of design on the reverse, the sole concern being to mass the colors on the surface in such an order as to create the desired pattern.

The figured stripe in B-1225 is the finest example of double-faced bobbin-weave in the entire collection. The design treatment is original, using a geometric conception in a most skilful fashion. The colors are clear and

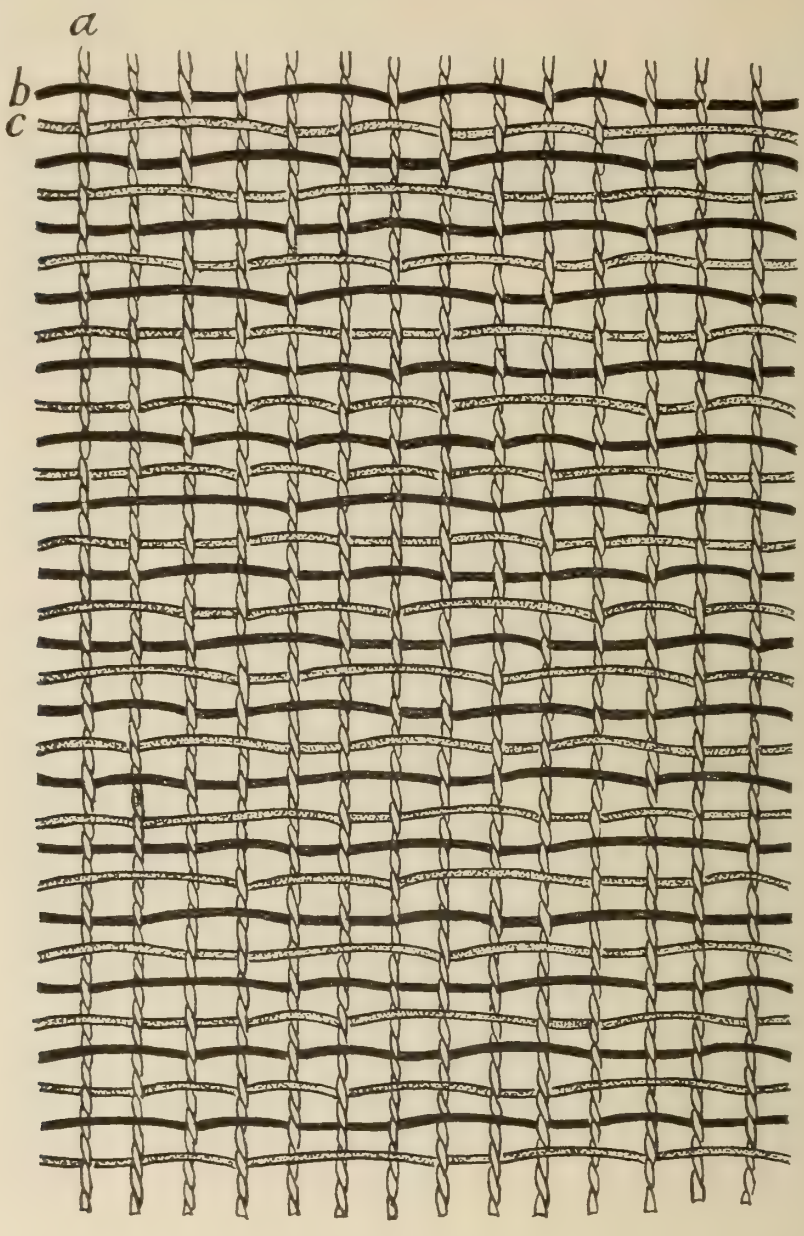

Fig. 27. Border of Bobbin-Weave. *a*, warps; *b*, red weft; *c*, yellow weft.

harmonious. The unfigured portion of this marvelous fragment is tapestry, containing 44 three-ply cotton warps to the inch and from 260–280 two-ply vicuña. Reference was made to it in the first paper. The lack of certainty in regard to weft count was caused by the great tenderness of the picks. They often broke when being withdrawn, and the allowance made was an endeavor on the writer's part to strike a proper average. It seemed

a useless desecration to destroy another inch of this masterpiece. The bobbin-weave stripe appears to be quite as fine, though perhaps the nature of weave causes it to approach nearer to the lower figures. Originally, the fabric was perhaps twenty-three inches wide, the stripe is about three inches in width, the take-up in this fabric is entirely in the weft and must be at least twenty percent. The stripe contains therefore 780 picks of weft, and each appearance over or under warp had to be considered in forming this design. Aside from the stripe, the entire fabric was about thirty inches long. Figuring 280 picks to the inch, in the plain portion this would give 8400 plus 780 in stripe which equals 9180 weft picks in the fabric, each pick was 23 inches long with at least twenty percent added for take-up. It therefore required 263,368 inches or 7315.77 yards of weft to weave this fabric. The allowance for take-up in the weft is entirely guesswork and was probably much greater than estimated. Considering the stripe alone, we find that design of a complicated nature was formed in a space three inches wide and twenty-three inches long, by the interlacing of 780 picks of weft with 44, the number of warps contained in an inch, multiplied by 23, the width of the fabric in inches, or 1012 warp ends. This, of course, is far too complicated to be ascribed to sheds formed by healds. The weaver simply darned this stripe and instead of assuming any ridiculous number of heald rods, we may safely attribute this stripe to the skill of the weaver in darning.

This remarkable organization is rather a tribute to the spinner as without perfect yarn of great evenness and smallness of diameter, the weaver would be unable to achieve such marvelous results. Mechanical skill is the natural result attained at some period in a craft universally practised in one locality for great periods of time. It is to the philosophical basis of this technique (if I may apply such a term) to which the reader's attention is directed. Here is a highly complex design built up one pick of weft at a time, requiring 780 picks to complete it. Each crossing of weft over or under warps, causing a minute spot of color on face or reverse, had to be considered in advance of each pick. It is perfectly woven, in no instance does weft go over or under warp more or less than the design required. How such weaving was possible without some form of draft or diagram to go by is most extraordinary. There is a great similarity in design in Peruvian webs, but no two are exact duplicates. Each, if woven today, would require an individual draft. No doubt the conventional geometric figures, which appear to be the common property of other advanced textile races and the realistic representations peculiar to Peru, were well-known to each weaver, but the mechanical structure of each fabric had to be thought out by the worker almost independently of every other. It is barely possible

that the knotted strings known as quipu still used in the highlands of Peru to keep the tally of herds, may have been used as a guide to weaving, but no evidence of this exists, and in no instance, does the writer recall finding any examples of this ancient counting method in work baskets of the buried weavers.

In Wm. S. Murphy's "Textile Industries" the method of weaving cashmere shawls is described. The case is by no means analogous, but serves to show how some apparently complex methods admit of rather simple explanation. One man made the design in black and white; a second decided the color combination. This was read to the actual workman in a kind of craft argo — as each figure was traced in India ink on the bare warps, the weaver tied the proper amount and color of weft in its proper position on the warps.

The writer has observed skilled workmen repairing large holes in valuable rugs, containing complex design. No drafts were used, the weaver knotting in the pile knots in their proper relation on the new warps, apparently by instinct. But, if the instinct, so-called, were not backed up by years of practice, the result would be disastrous. The probable explanation of the enigma is that where textile art is so generally practised and carried to such a remarkable degree of complexity, the people may be said to think in textile terms. How strong the tendency is, becomes apparent when we see textile figures transferred to pottery and stone work.

In the period we are considering, each weaver of Peru, had at his command a great number of textile designs, the heritage of centuries of practical experience. He may have been able to combine them in whatever colors his taste decreed with the same lack of extraneous aid that an artist requires to combine his pigment into a picture.

If we endeavor to explain this manipulation by the extensive use of healds the following facts must be considered. All warps that required to be lifted at one time would have to be tied to a separate heald rod. So varied are these groups that the heald rods would cover so large a space on the warps as to make weaving very difficult, if not impossible. Reference was made above to the take-up incident to the crossing of warp and weft in weaving appearing only in the weft. The hard twist in the warp partially accounts for this, but the way in which weft was inserted perhaps plays as important a part. The bobbin was used like a needle and each pick was darned over or under warps, the plane of which was never disturbed. Take up is the extra length of yarn necessary in weaving calculations to account for the distance taken up by the interlacing of the warp and weft. This appears mostly in weft, the softer yarn naturally yielding more to pressure. For example, in our weaving, to get a fabric a thousand yards long, about twelve hundred yards of warp are necessary.

In the Peruvian web under consideration the warps are very hard and the weft comparatively loose in twist. There must have been great tension on the warps in the loom to allow for the degree of beating up necessary. The weft was picked in a slack condition. When a pick of weft is withdrawn, it shows the deep indentation of the warps, whereas warps are perfectly straight. Therefore the take-up was entirely in weft.

TIE DYEING.

Among the many fabrics from Peru which suggest so forcibly the textiles of Asia, none is so difficult to explain as a form of resist dye known as tie dyeing (Fig. 28). In resist dyeing fabric is so treated that when put in the dye pot, only certain portions of it absorb the colors. One form of this craft was to tie little bunches of cloth with a cord either soaked in clay or wax or spun from fiber which has no affinity for the colors and then dip the tied web into the pot. This tying was done in such a way as to produce design by the small circles or rough squares covered by the cord and therefore left undyed. By tying different knots while leaving the original in place and starting with the lightest shade for the first immersion, it is possible to produce designs of many colors.

The Punjab perfected many different forms of this technique. The most remarkable was one in which both warps and weft were tied at carefully arranged intervals and woven so the corresponding spots came together in the fabric. Another was to tie small portions of the warp with strips of bark before weaving and then dye it; a third, was the one mentioned above in which the woven fabric was treated. This last mentioned technique gave its name to the bandanna kandkerchief.

It is curious to note how persistent certain of these methods are. The Moslem conquests spread tie dyeing of fabrics into the Philippines, the Bagobo tribes being especially skilful in its use. No doubt webs of this character have been found among a Nigerian tribe, who learned the craft from the Arab traders. How ancient the craft is, can only be estimated. In the Metropolitan Museum of Art is a small fragment of Saracenic silk in which the warps had been subjected to this process. This fragment is attributed to the seventh century. In the Museum of Decorative Art is a second much larger specimen dating from the tenth century. The change of color in the continuous thread was at first very confusing to the writer. Later, however, a study of Sir George Watt's "Art of Delhi" cleared the

matter up. We can also safely say that the Moors carried the craft into Spain, and the Spaniards in turn carried it to Mexico along with the silkworm. Today the weavers of Guatemala apply this craft of ancient India to silk and cotton fabrics.

In dwelling so long on subjects not directly pertinent to this paper, the writer's purpose was to show two facts. First, that this method readily appeals to every people even slightly familiar with textiles, and second, wherever it appears, except in one place, its Asiatic origin can be clearly traced. This exception is Peru.

There are certain features of originality about this technique which make it difficult to see how it could have developed gradually. The whole process is required to produce design, and the several operations apparently owe their invention to a single mind. The evolution, so clearly suggested in other processes of weaving, is here absent or extremely vague.

The craft in Peru, as far as we know, never extended beyond the simplest form. This nevertheless, was carried to a certain degree of perfection. It seems difficult to say that such an unusual method was the result of an intellectual accident in Peru and Asia, while in every other place where it appears, there is historical proof of its origin. Like gauze, this technique is very suggestive.

Fig. 29 is an interesting example of one form of resist dyeing. A light loosely woven cotton fabric has been decorated with alternating stripes of white and brown. It was first doubled on the bias and then rolled up in a long cylinder. There is nothing to show exactly how the brown stripes were formed, but the probable method was that in the space covered by the white stripes some fabric was tightly wrapped and then the whole thing was dipped in a dye pot. The stripes correspond through the entire thickness, and this would be impossible if the stripes had first been painted and then the web rolled up. The effect of folding on the bias is that the stripes run diagonally to the warps. This process, to the best of the writer's knowledge, is peculiar to Peru.

No examples of fabrics actually tied for dyeing are in the collection. A later form practised in India today and applied directly to modern printing, was to cover the surface to remain undyed with wax. After dyeing, the wax is extracted. In this work, however, the figures are clearer and more regular than where the irregularity of the strings allowed the colors to penetrate more freely to the edges of the undyed surface. The use of string is certainly the more ancient method and coupled with the peculiarity of Peruvian work, may be more certainly accepted as the method employed.

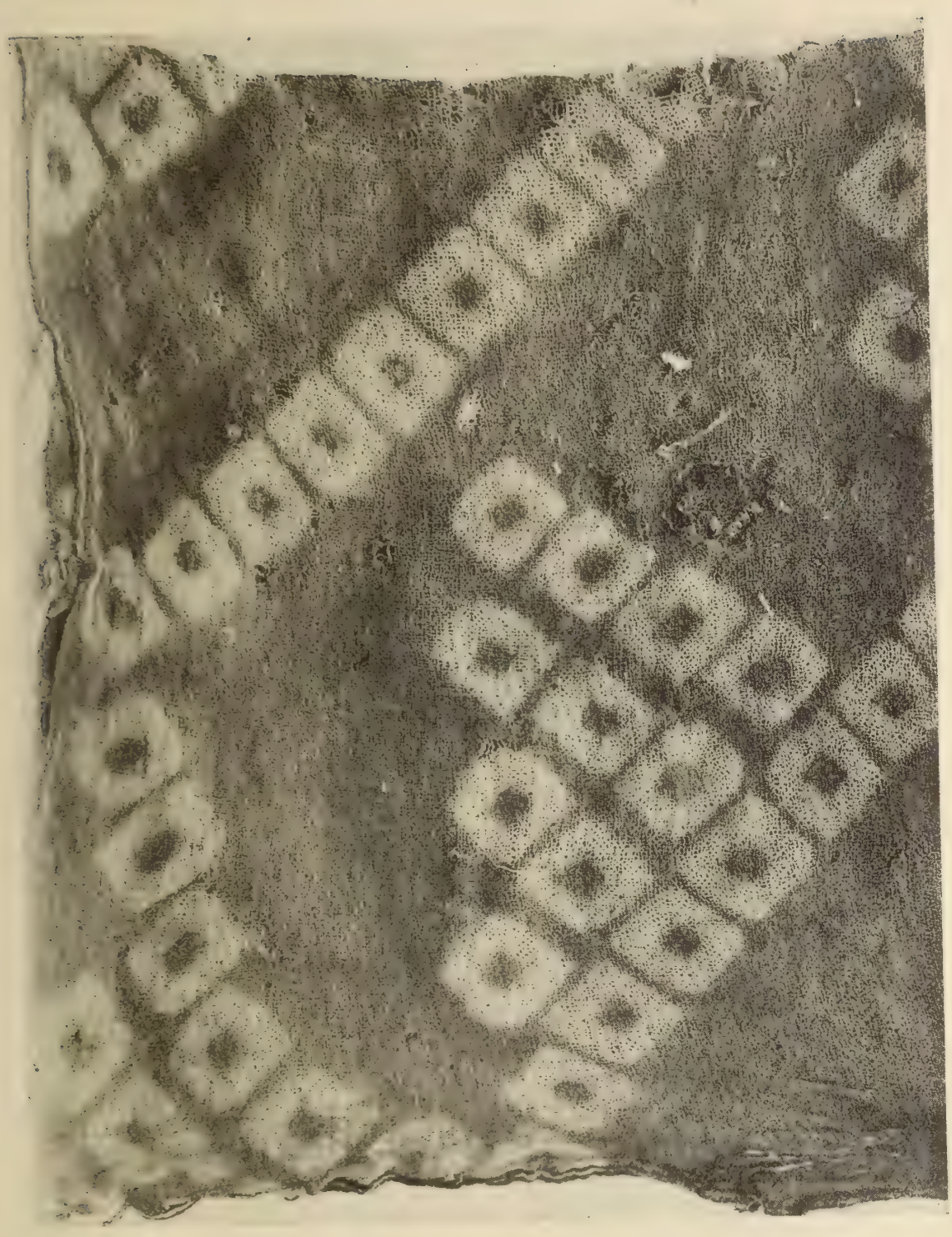

Fig. 28 (B–1264). Tie Dyeing or Bandanna.

Fig. 29. Methods of Tie Dyeing in which the Cloth is rolled into a Cylinder, then Tied and Dyed.

PILE KNOT.

The commonest forms of pile knot in Peru are found in the ornamental ropes, the use of which is not quite clear (Fig. 32). A few fragments of narrow belts or bands which show a rather more extensive knowledge of this interesting technique than the number of examples would indicate, have lately come to light. These fragments contain designs formed by attaching knots of colored fibers to a basic fabric. Two slightly different methods were employed, and in one example, two colors and in the other five, have been employed to produce design. While their surface appearance is the same as Oriental rugs, they are quite distinct from a technical standpoint. The carpets of Asia are decorated by knots of dyed yarns so loosely spun as to readily separate into fiber after being attached to the basic fabric, but this does not obviate the fact that they were originally yarns. A careful examination of a number of knots from the Peruvian webs, proves them to be merely untwisted bunches of fiber. But the great difference between the two techniques lies in the manner in which these yarns or bunches of fiber were incorporated in their respective fabrics. Roughly speaking, the Oriental method consisted in knotting short pieces of colored yarn to the warps of the fabric and binding them in place by the insertion of weft. The basis is in reality a plain woven fabric, containing the two essential elements of warp and weft. In other words, every rug contains three elements: warp, weft, and pile knot. Peruvian webs of this character contain only two elements, bunches of fiber of a decorative character, and a single thread which is looped upon itself in such a manner as to form a very open knitted web. The knots are caught in portions of this fabric as they are being formed. The diagram will show this much more clearly than can the written text (Fig. 30). *a* represents the cord looped on itself to form the basic fabric; *b*, represents the knots of wool and hair. It will show that in a technical sense no two fabrics could be more unlike. Rugs are plainly a development of woven textiles, they belong to a class closely related to tapestry. In fact, the earliest rugs were unpiled kelims or actual tapestry. The Peruvian fabrics, (Fig. 31) on the other hand, belong rather to the division of fabrics of which lace is the highest form, and are a development of nets. After these knots were attached they were cut so as to give an even surface. This cutting is very even, but we have no knowledge as to the implement used.

Compared with tapestry, pile knot is a thing of yesterday. There is

strong evidence to support the theory that the modern form of rug came into existence rather late in the textile development of Asia. The use of fabrics for a floor covering and as hangings no doubt had a tendency to suggest some form of textiles resembling fur, and while no shred of evidence remains to prove the theory, perhaps some intermediate form arose in which a partial use of pile such as tassels gradually evolved into the modern carpet. Tassels were very often used in decoration in Peru. A highly ornamental loin cloth formed from a net covered with red tassels is in the Museum collection. This may be the prototype of the pile bands described above. In Peru there were no fabrics except the sleeping mats which were unquestionably floor coverings. It is not too much to assume that had such a want arisen, these skilful weavers would not have been long in carrying the technique still further and at last attaching the knots to the warps of their tapestries.

No definite use has been assigned to the pile knot cords of Peru (Fig. 32). That their function was largely ornamental there can be no doubt. Perhaps they were ceremonial llama harness. From their great length it seems doubtful that they could have been used as belts. They vary in thickness from a scant quarter of an inch to perhaps three quarters, and in color from solid red and dark yellow to red and black and are composed of narrow alternating stripes of yellow and brown.

They are composed of three elements (Fig. 33). The core contains three two-ply cotton yarns twisted together. The pile knot or loop is composed of a mixture of wool and hair, and the small hard twisted yarn which binds the fiber to the core.

So far as can be determined, both these piled fabrics are peculiar to Peru. They occur no where else in the world. They indicate better to what an extent the ingenuity of these people had developed along textile lines, than could a volume of mere assertion. From the fact that the belt-like pieces, although few in number and selected in a haphazard manner, still show two distinct methods of attaching the knots, and from the evident ease with which the technique was employed in the production of design, it would seem but reasonable to hope that further excavations may uncover much more extensive collections.

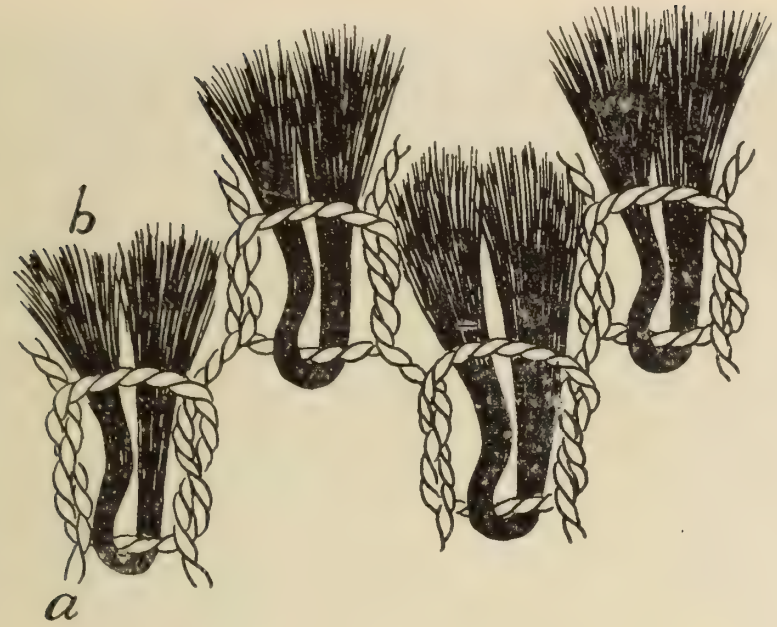

Fig. 30. Pile Knot. *a*, the basic fabric, a single yarn knotted on itself; *b*, the pile knot caught in the knots of *a*. In the fabric the loops are much smaller in relation to the knots, than in the illustration. The knots are hair and wool and the cord is a two-ply closely twisted cotton.

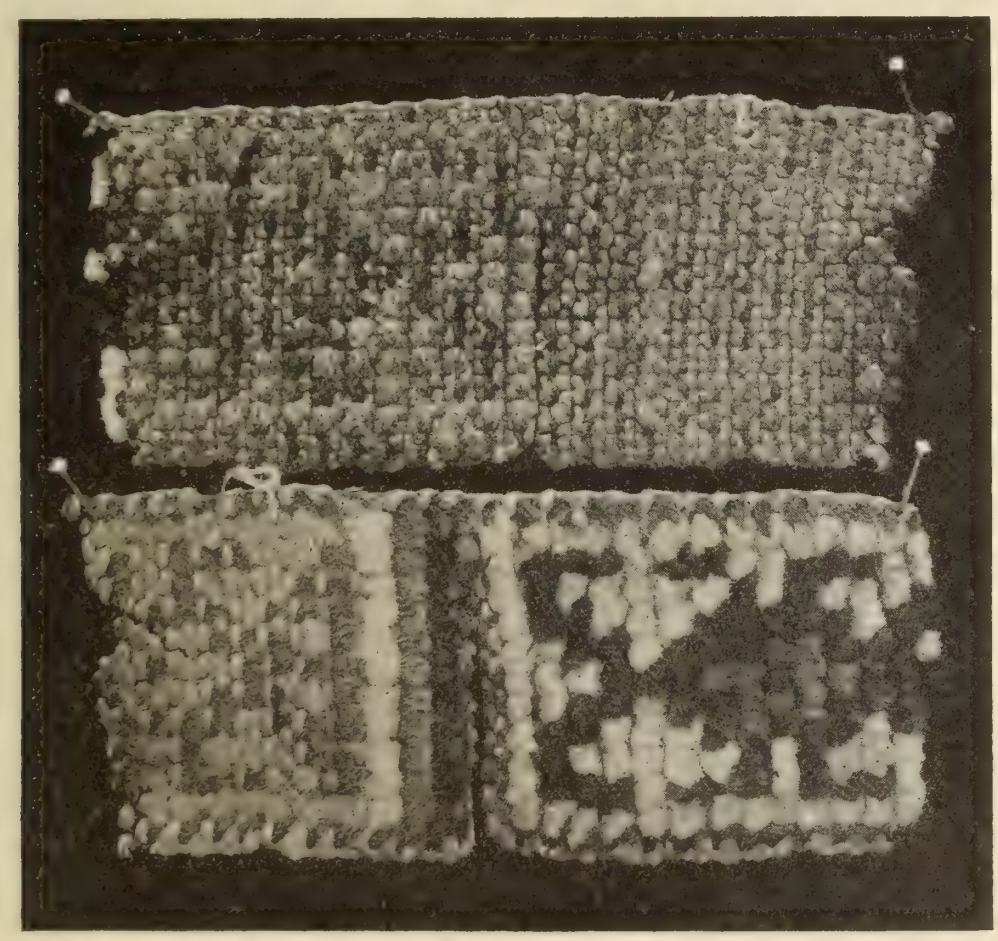

Fig. 31 (B–4751). Pile Knot Ribbon containing part of a conventionalized Human Figure.

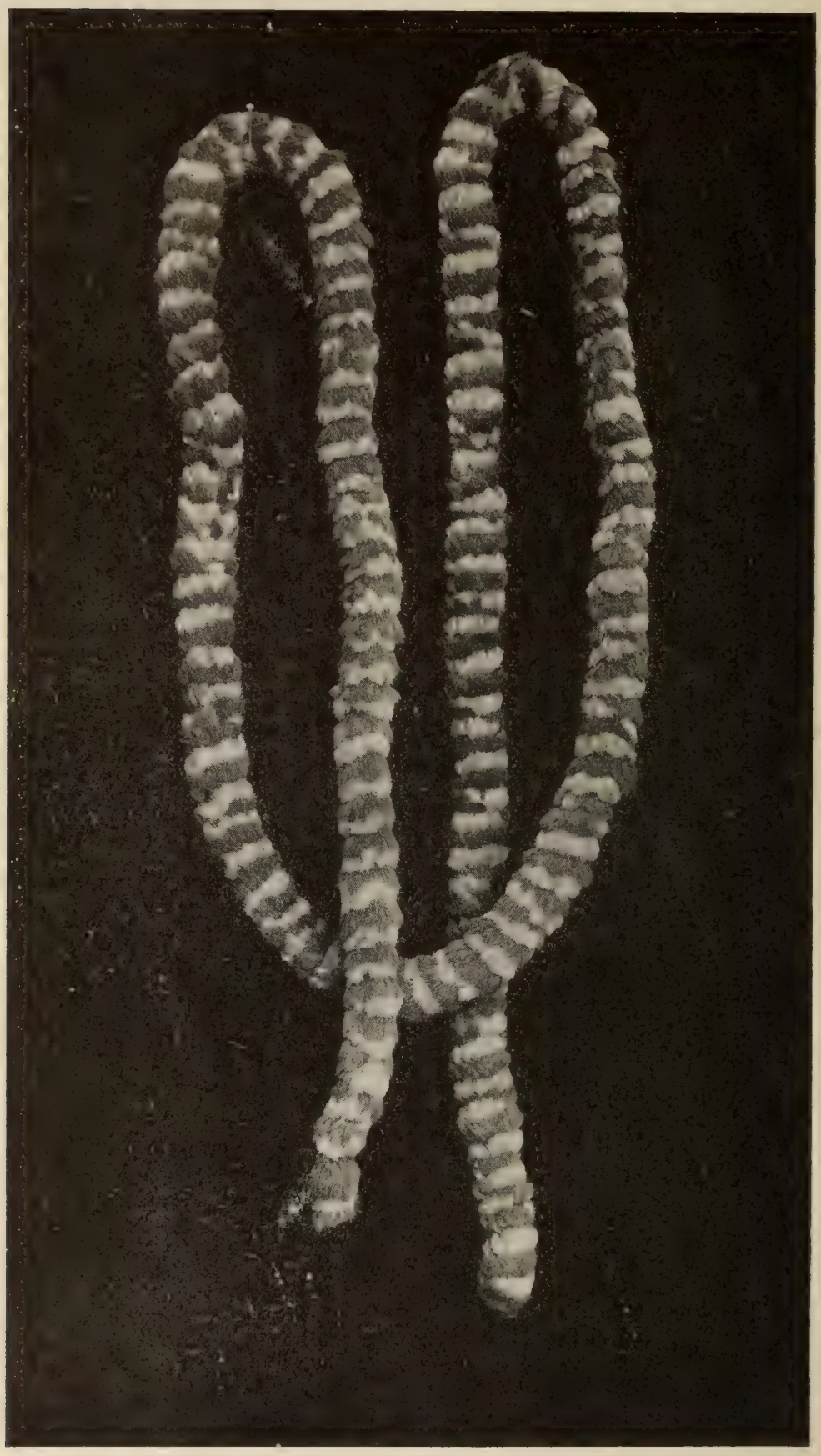

Fig. 32 (B–582). Pile Knot Cord.

Fig. 33. Two-color Pile Knot Rope: *a*, binding cord; *b*, the three cords, which twisted around each other, form the core; *c*, *c*,′ *c*,″ the knots caught in *a* and wrapped around *b*.

MISCELLANEOUS TECHNIQUES.

Certain Peruvian textiles do not readily lend themselves to modern classification and yet are so interesting as to deserve description. B-8695 is a maguey fiber lace bag. The designs have been skilfully knitted in the webs and then emphasized by painting the plain portion of the bag. They have not been dyed, but actually covered with a paste-like substance containing the coloring matter. The yarns in these bags are two-ply maguey, very finely spun and containing an amazing degree of twist. This twist gives them a very wiry feeling.

There is a poncho in the collection resembling a rough Turkish towel. A somewhat similar method of decoration was used by the Coptic weavers and occasionally they carried the craft still further and inserted colored yarns in the looped wefts. Between every ninth warp the weft has been pulled out so as to form a loop. These weft loops hang down in a fringe separated from each other by a space in which the weft had been inserted in the ordinary way for ten picks. The loops are longer than the width of these plain strips and cover the entire surface of the poncho.

The old weavers of Peru had a great aversion to leaving the edges of their garments undecorated. Generally, the last two or three inches were covered with a border of different design and color and often woven by a distinct technique. Besides these borders, fringes were often attached. Sometimes these were neatly sewed so that the thread only appeared on the back but more often they were incorporated in the fabric of which they formed a decorative element. In hand loom webs, the warp and weft are continuous threads. At the selvage and at the loom string they are turned back into the fabric and leave loops, to which the fringes can easily be attached. Fringes were sometimes made by twisting pairs of unpicked warps together. These turns are very close and apparently are held in place by the force of the original twist. Perhaps the twist was secured in some other way at first and permitted to set before released. B-1284 is a sleeping mat. The fiber is cotton and the soft mat-like surface is obtained by the use of slubbed weft yarns. The warps are two-ply cotton hard twist so as to firmly lock the weft and to bury itself in softer twisted yarn. The weft is also two-ply between the slubs sufficient twist being inserted to make the yarn strong enough for weaving.

The plain cotton ducks of Peru vary from rather fine construction as specimen B-8742 containing 142 warps and 44 weft per inch to ones con-

taining 40 warp to 12 weft and even coarser weaves. Generally, the yarn is two-ply cotton and of very excellent spinning. It is curious to observe that the number of warps is greatly in excess of weft. This is the cheapest way to weave modern fabrics since the warps are all drawn in the loom at one time and the added labor cost of a reasonably fine warp over a very coarse one is very slight and does not interfere with the speed of the loom, whereas any appreciable increase in the number of weft pick material decreases the loom production and therefore raises the labor cost out of proportion to the increased fineness. It is interesting to note that this practice was well understood in Peru. It appears even in ornamented webs such as warp stripes. It must have required a very nice adjustment in the drawing in of such numbers of warps on these simple looms so as to equally distribute tension, and also afforded an ideal use of heald rods in making the sheds. The beating up of weft must have been a rather difficult process without the aid of some modern reed in fabrics containing large numbers of warps and this may account for the comparatively light picking.

B-8685 is a portion of an ornamented loin cloth. The decoration is a kind of embroidery resembling a chain stitch (Fig. 16). The yarns have been sewed through the basic fabric and then knitted together on the surface. Knitting was quite common in Peru, such examples as the woolen caps and bags being the ones met with most often. The combination of this technique with true weaving was a very natural development. There is a rare form of Oriental rug in which the same method of ornamentation is employed. The basis of the web is a loosely woven cotton duck and the embroidery covers this completely. There is apparently some confusion in names for this class of work, sometimes it is referred to as a Cordova or Moorish and again as Cashmere. However, a confusion in the names of Oriental rugs, based on the supposed place of origin or barter is by no means uncommon, and anyone familiar with the class of carpet referred to will have no difficulty in seeing the relationship here evident.

Lace is generally assumed to be a later textile refinement, but its origin in useful fish nets makes it certain that many techniques were as old or even older than true woven design. In the collection are many fine bags made from two-ply yucca fiber yarns. The illustration is of a broad ribbon of lace. It is cotton and shows the conventional interlocked bird heads as its principal design (Fig. 34).

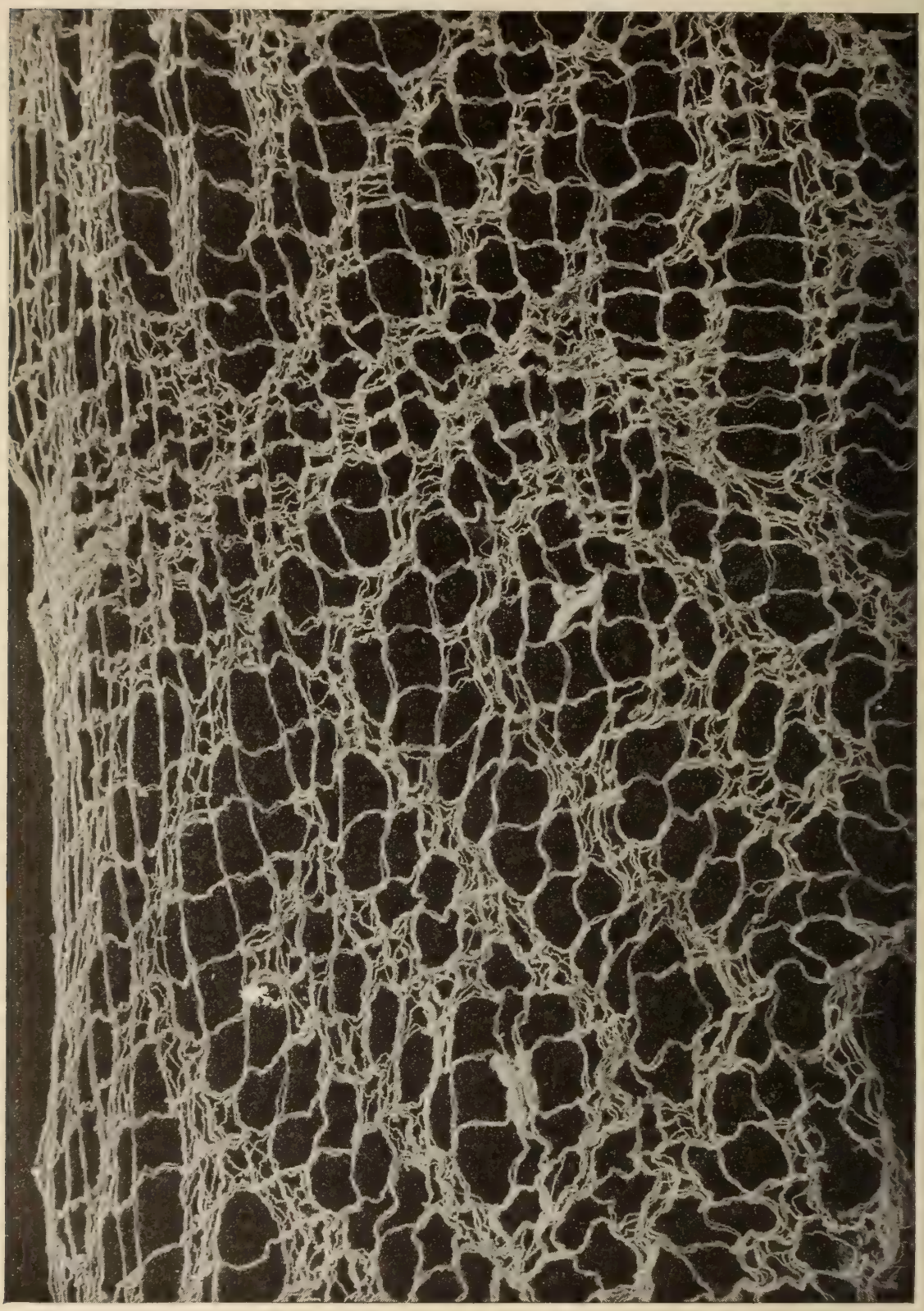

Fig. 34. Lace.

MECHANICAL DESIGN.

The term mechanical design has been chosen to designate a class of ornamentation produced solely by the mechanical operation of weaving. The patterns are absolutely devoid of either realistic or symbolical meaning. For this reason, since double cloth, gauze, etc., are occasionally the vehicles for conventionalization, they are excluded from this chapter. Warp and weft stripes, and their combination in plaid or ginghams, fancy warp stripes, and certain fabrics decorated by warp manipulation will be chiefly considered. However, examples of pure geometric figures in tapestry and a mechanical explanation of their origin are discussed.

When weavers began to use dyed yarns, either for embroidery or tapestry, it soon occurred to them to pick a bobbin of colored weft right across the warp. This produced a stripe of color in the weft. This stripe would be a solid color except where the undyed warps appeared on the surface at the intersection of the warp and weft in weaving. This refers to fabrics which are not tapestry. Its width depended upon the amount and size of the weft used. This must have been a very early method of design and is used today by peoples having only slight textile knowledge.

Soon, however, the idea of making stripes run the length of the web took form. This was accomplished by drawing in the loom, larger or smaller groups of warps of color different from the rest of the piece. Here the width of the stripe varied with the number and size of the warp ends it contained. This was rather a mechanical advance since it required more forethought to arrange a parti-colored warp than merely to insert a bobbin of dyed weft until a stripe of the desired width was complete or until the bobbin was empty. Many very fine shawls are ornamented with plain warp stripes differing in width and in tone, forming a most pleasing combination. The fabric (B-5449) contains 104 warps and 34 weft per inch. The yarn is two-ply cotton, the warps handsomely dyed. The great predominance of warp and the careful crêpe twist in the yarns causes this set of threads to appear only on the surface. The fabric is ribbed like tapestry but the repp is produced by weft and not warp as in the former example. In this fabric there is no deviation from a plain weave, but in B-1379 we have a fancy stripe produced by the order in which certain warps are left unpicked. This may be said to be the exact reverse of bobbin-weave where design is produced by the weft going over or under varying groups of warp, since these warps go over varying groups of weft in the production

of design. Similar figures are produced today by means of extra heddles on simple harness looms. They are caused by warp appearing on the surface for a few extra picks of weft.

No doubt, weft striping and warp striping were both well advanced before the two methods were combined in a single web to form simple check or gingham patterns. There can be little doubt, however, that this method is very ancient, for it has been carried to a remarkable development and a great variety of patterns appears in the specimens on exhibition in the Museum. These pieces bear an interesting likeness to modern fabrics. This is not so remarkable when we consider that combinations of colored warps and wefts have been made for centuries in both parts of the world and the ultimate results achieved would very likely be similar. It is interesting to note that most modern gingham patterns are but copies of ancient Scottish Tartans.

It will be seen at once that careful arrangement of warp so as to have the colors in their proper positions was the first necessity of this class of weave. Next, bobbins containing the different colors of weft were prepared and inserted in the order necessary to produce the pattern. The whole operation required a careful consideration and calculation. Where warp and weft of the same color interlaced, areas of solid color would be produced, but where yarns of different shade combined, there would be a stripe or square of a shade composed of the two. The characteristic slack weft of tapestry and bobbin-weave which allowed the weaver to completely cover his warps was absent in these fabrics. Both filetal units appeared in the web and therefore the designer had to make allowance for each. The many complicated patterns are sufficient evidence that this class of textiles was well represented in ancient Peru. However, it is but fair to say that in this technique at least, the product of modern mills is superior.

Fig. 35 represents a rather unique weave. It is an ordinary gingham shawl composed of two fabrics which have been sewed together, and has a border of single-faced bobbin-weave, rather coarse in texture. The designs in both fabrics are the same, but curiously enough, the units seldom correspond in size. Evidently, no exact draft was used in weaving or the fabrics would more nearly correspond. The pattern is a series of rectangles more or less even. In each rectangle is a second square or oblong of white. This is produced by combining the white warp and weft in this portion of the web. The white warp is crossed by no other weft and the white weft picks or other warp in these figures. This is what is called floating a figure on the surface of a fabric (Fig. 36). It is an application, in a small way, of double cloth weaving and probably explains the origin of this latter class of fabric.

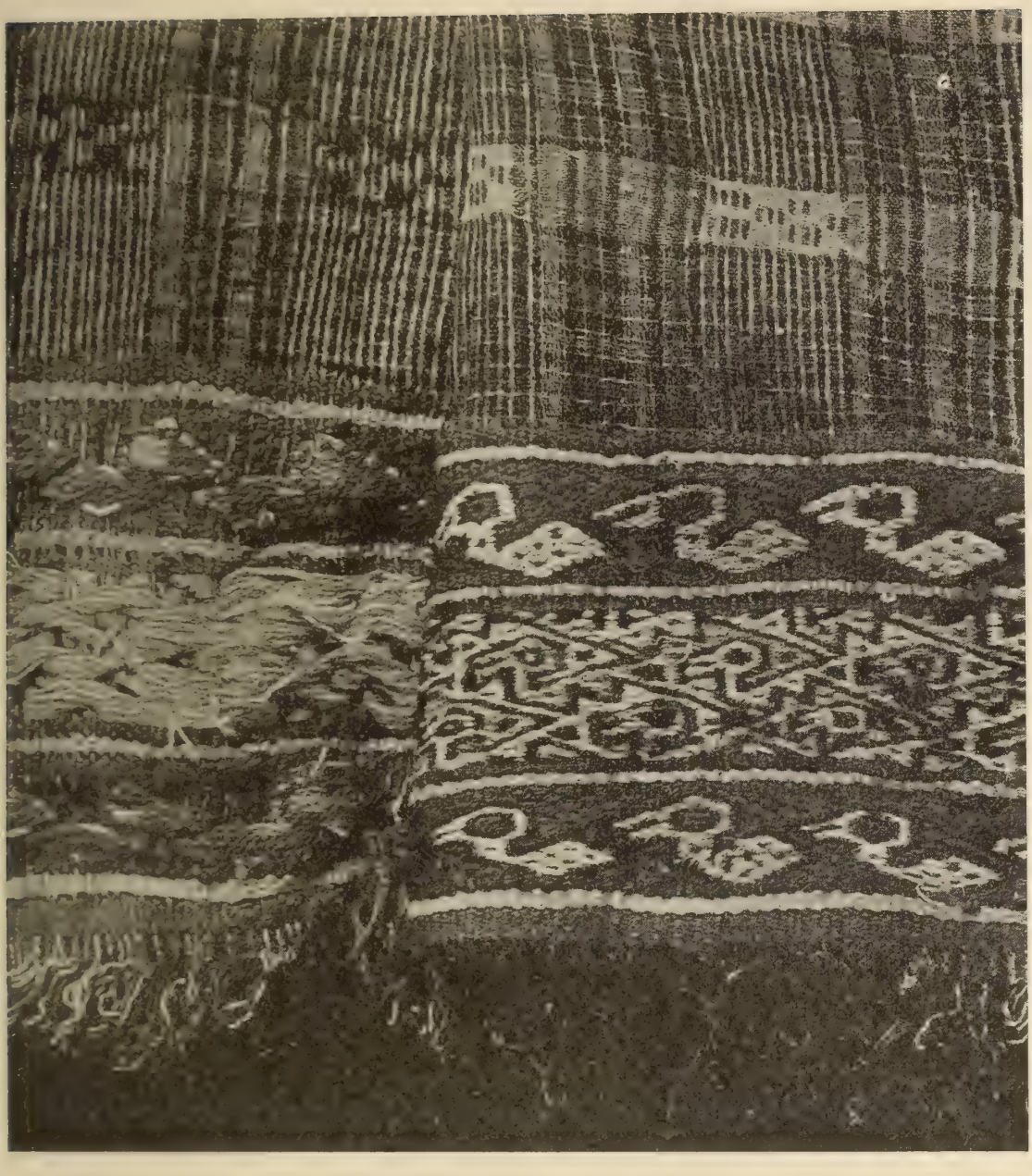

Fig. 35 (B–4319). Gingham with floated White Lozenge Figures having a single-faced Bobbin-Weave Border.

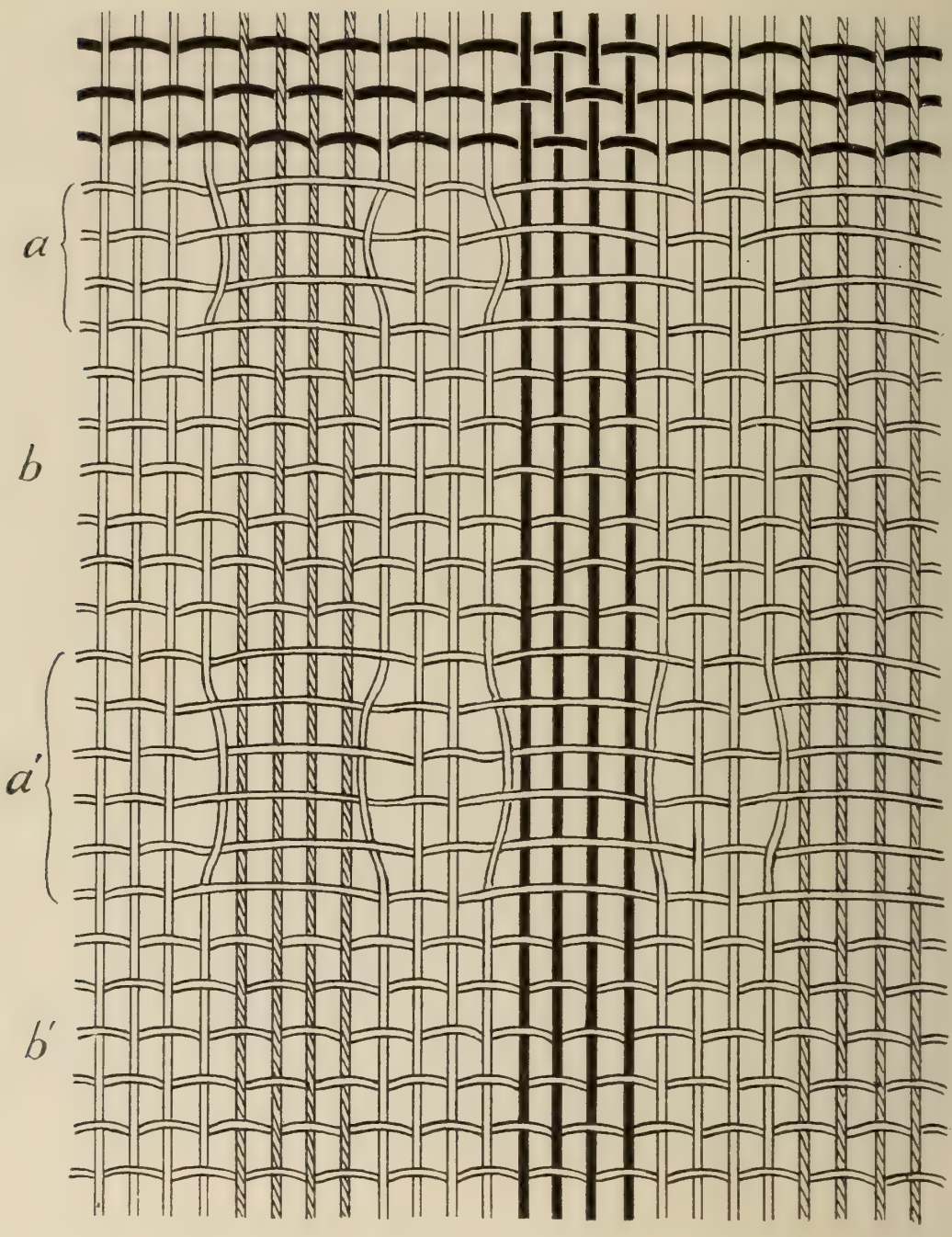

Fig. 36. Diagram of Cloth shown in Fig. 35. *a*, *a*,′ portion of the web in which the white warps are picked only with the white weft, forming the white surface; *b*, *b*′ portion of the web in which the interlacing of warp and weft of the different colors is in regular succession.

Referring to the mention of the origin of double cloth, it can easily be seen that most styles of weave have been suggested by simpler forms. A weaver becomes extremely skilful in a certain technique. In attempting to relieve the monotony of the product, certain slight modifications are indulged in. The accretion of these weaving tricks ultimately becomes so great that they create a new type of fabric perhaps very different from the original web. In the example under discussion, it appears that a novel effect was produced by combining the white yarns for a short space. Carried a trifle further, assume the two browns also to have been combined, etc. The weavers must have been dull indeed not to comprehend eventually that by so combining different sets of warp and weft in the above manner, a distinct type of fabric would be the result.

Fig. 37 is a photograph of a narrow belt. It contains a simple but pleasing geometric design of gray and black. The pattern is produced by the ap-

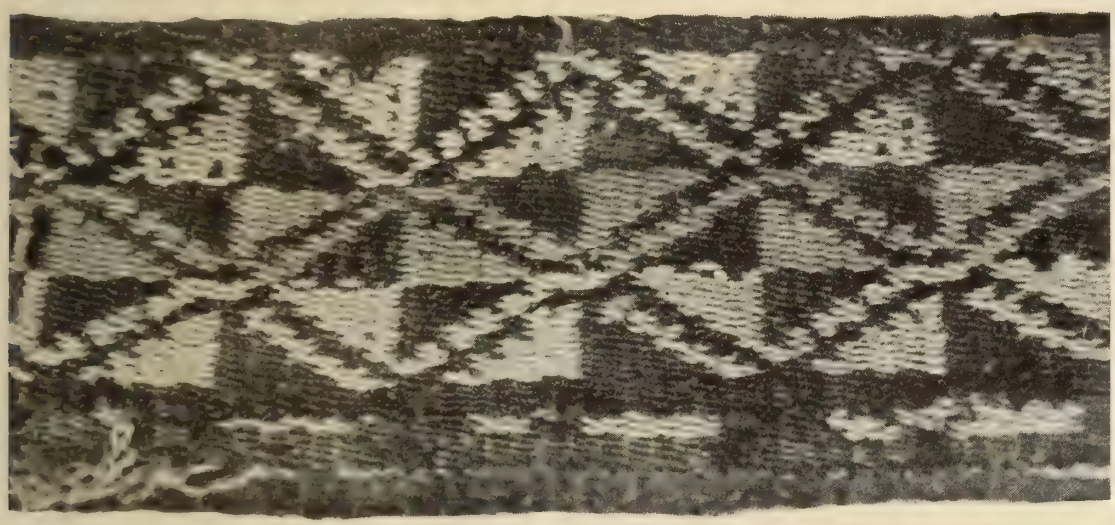

Fig. 37 (B–4642). Narrow Belt in which Geometric Design is produced by contrasting Warp Colors appearing on the Surface or Reverse.

pearance and disappearance of these colored warps on the surface of the belt. Both sides contain the same designs but the color proportions are reversed. The texture is very solid and the fabric is still remarkable for strength. This technique must have been very desirable to primitive weavers. It occurs over almost the entire cotton area. Fine examples of it are woven in modern Colombia, among the wild tribes of Nicaragua, among the Navajo and Hopi, and in many other districts. In some respects it resembles double cloth which is also very widely distributed. I doubt if this is indicative so much of early origin as of a convenient and simple method of decoration.

Examples of tubular weave occur in Peru. The warps produce design. Such ends as are not required in any portion of the fabric serve as a core and

are picked up and exposed on the surface wherever design requires. The colors are exactly reversed on opposite sides and at intervals the entire color scheme changes from one side to the other. The end of the tubular weave is composed of a knitted fabric in which all the warps used in the web are combined without the aid of weft. No exact duplicate of this technique exists today and only the most general idea of the processes of manufacture can be conceived. It is but another example of patience and skill.

The above examples by no means exhaust the techniques which might properly be considered under this heading. Sufficient, however, have been given to show the wonderful versatility of this people in the mechanical problems incidental to weaving.

The ginghams are almost always of cotton and the condition of the dyes is very remarkable. This fiber is, excepting linen, the most difficult to dye in fast colors. Perhaps the best results were obtained by dyeing in the fiber instead of the yarn. A small ribbon of dark blue cotton fiber was found in a gourd and perhaps represents one of the processes. However, dyed cotton warps are illustrated in the chapter dealing with the drawing in of warps in the loom and some fabrics have been dyed in the piece in dark blue and one in a light shade of lavender, and even these have kept their color after all the centuries. It must further be borne in mind that there is no evidence that these fabrics underwent any finishing process after leaving the loom, with the trifling exception of piece dyeing mentioned. Our modern webs are vastly improved in set and appearance by the subsequent finishing processes.

All kinds of textile design in which the units are balanced or in which the same figures are repeated, require some form of prearranged plan. Even in plain weaves, the fact that each square inch of fabric contains almost exactly the same number of warps and weft, necessitates calculation which commences with the spacing of warp in the loom and ends only with the final beating up process. In tapestry it was necessary to estimate how many warps each figure would cover, and how many picks of weft would be required to weave it. In embroidery a similar calculation was applied to each figure with reference to space it should occupy on the web. This space was estimated in terms of warp and weft, but the calculations in both these styles were so simple, as to require for their successful application little more aid than that offered by the nice sense of proportion incidental to fine craftsmanship.

Quite a different condition arises when such complicated methods as double cloth, bobbin-weaving, brocade, and gingham are considered. These techniques required most careful and complicated prearranged plans. That these plans took a form in any way resembling modern mill designs is doubt-

ful, certainly there exists no proof of any such designs. However, some form of plan or notation must have existed unless we are to assume a degree of memory sufficiently great to carry in mind the exact relationship of hundreds of threads crossing each other at right angles. Examples of great feats of memory among primitive peoples are not wanting, and the skill of Oriental hand loom weavers in producing webs of cloth with little aid from diagrams, such as are indispensable to modern weaving, is too well known to require comment. When a certain figure or group of figures repeat in design, the most difficult calculation is of course the first; the balance being merely repetition. When once such a pattern had been worked out, the details might easily be committed to memory. However, this could hardly apply unless the subsequent fabrics were exact duplicates of the original. Any deviation in count or proportion would require a separate filetal arrangement. In Peru there are strong resemblances between many fabrics but exact duplicates never occur. Therefore, each web requires a separate calculation, at least sufficient to comprehend this slight difference in texture or design.

In bobbin-weave the appearance and disappearance of two alternating colors of weft had to be carefully arranged for. In double cloth the raising or lowering of two warp and weft elements was planned in advance. In ginghams, the interlacing of warp and weft was the same as in plain weaving, yet a careful calculation as to just where the different colors of warp and weft should cross contrasting shades or where combined with the same color, was necessary to the production of well-balanced patterns.

In other words, the exact spot where these different things were to take place had to be arranged before the operation of weaving began. In bobbin-weave the order of picking alone required consideration; in double cloth, both warp and weft required attention; and in gingham, a further planning was necessary since here the process commenced by a careful arrangement of the different colors in drawing in the warps. The space each figure was to occupy on the warp surface was therefore calculated before the bobbin was nserted in the warps. Now space in weaving is estimated not only in inches but more particularly by the number of warps one way and the number of wefts the other. This required a degree of mathematical calculation by no means contemptible. It must be further borne in mind that every square inch of each fabric, except in the cases where the technique varied, contains almost exactly the same number of warp and weft. To accomplish this, every operation of weaving from drawing in the warps and spacing them in the loom, to beating up, had to be planned.

It is perhaps unwise to predicate undue conscious mathematical calculations in explanation of these facts. The subconscious dexterity of skilful

handcraftsmen is sometimes as exact in result as are the efforts of the scientific prearrangement. Besides this, some fabrics have at one or both edges, a small border composed of portions of the figure of the design. This may indicate that there was some mistake in the plan, although the desire to form a straight edge is perhaps as valid an explanation. However, this much is certain: the fabrics required careful counting of warp and weft to make them coherent in design. These calculations must have been in advance of the actual weaving, for certainly the results could not be produced by haphazard work. In order to accomplish this, a certain comprehension of abstract mathematics was requisite. In bobbin-weave or brocade this calculation included the use of both odd and even numbers.

TECHNICAL ORIGIN OF DESIGN.

The significance of similarity of design in different portions of the world is a problem for the professional anthropologist rather than the textile expert. The motives of art, environment, cultural relationship, and religion, are no doubt portrayed in the maze of figures. Somewhere lies the key to many mysteries of origin of apparently widely separated civilizations. The problem invites with all the seduction of mystery ever on the verge of solution, but the amount of ethnological and archaeological information requisite to these questions is rarely accessible to technical men and certainly is not possessed by the writer.

However, a certain amount of elimination can be accomplished by indicating a series of figures that appear to be practically universal in all weaving centers whether of basketry or true textiles. From the pottery decoration of the Swiss villages, copied beyond question from baskets, through Asia, the Pacific Islands, our Southwest, Mexico, and Peru, these figures occur. Even today many woven designs contain portions of them. It is generally admitted that the technique of weaving is the true explanation of this similarity, but I have never seen this explained in a technically thorough manner. Before passing to the diagrams which progressively show this, a word of caution may not be amiss. While the general form of the figures to be discussed may be accounted for on practical rather than aesthetic grounds, the same does not hold true of incidental detail. Where there is a similarity of detail that does not lend itself fully to further mechanical explanation, other fields of research are quite pertinent.

One of the earliest, if not the first, forms of woven design is tapestry.

In the chapter dealing with this subject, the openings in the web between contrasting colors on parallel warps have been discussed. Where colors come in contrast obliquely across the warp, these openings disappear, or

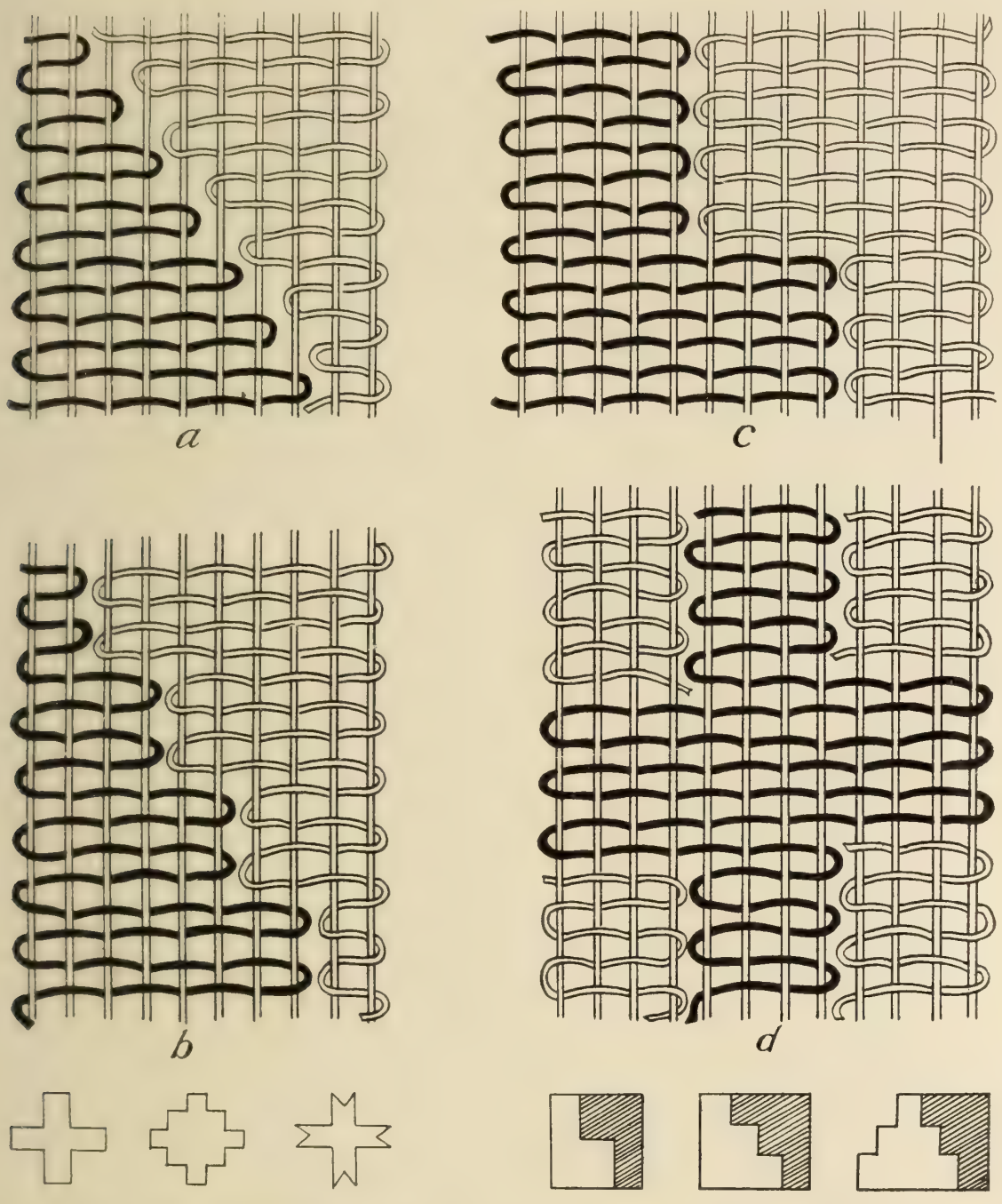

Fig. 38. Method in which certain Geometric Figures originated in the Technique of Weaving; *a*, a line in weaving where two colors come in contrast obliquely across the warps; *b*, slight accentuation of the step-like figure shown in *a*; *c*, the step-like figure carried still further; *d*, the method carried into a simple cuneiform. The small figures at the bottom suggest the different figures which have arisen from this technique.

rather are merely the width of the diameter of a single weft pick. This is so slight as to elude the unaided eye. Sometimes when exposed to a strong light the opening shows as a transparency. The significance of this is that

the so-called oblique line of color demarkation is in reality a series of minute step-like lines like the teeth of a fine saw, each tooth being distant the breadth of one warp end from the preceding. This angular deviation from a straight line, while imperceptible to the eye, could not fail to have been evident to the weaver, familiar as he must necessarily have been with the technique. (Fig. 38.)

By a well-known rule of primitive psychology, what a savage cannot avoid either in nature or art, he is likely to accentuate. Hairless peoples generally extract the few hairs that appear with tweezers, while hairy tribes take great pride in flowing beards. Therefore, weavers very soon began to increase this saw or step-like line by increasing the number of weft picks contained in each section of warp. The effect thus produced must have been very pleasing. The very angularity has a charm of its own, since straight lines and exact proportion are things which in nature a savage seldom sees. It is by no means unusual to see entire webs decorated with a series of rectangles, grouped in cross-like figures. The possible combinations of this simple motive are infinite and variation in outline or proportion produces individual traits. Sometimes the accidental likeness to some realistic form caused slight addition in detail which carried the design into the realms of symbolism. Again, in attempting the delineation of realism in woven webs, the application of the technique produced at times an angular suggestion which on being accentuated finally developed into a pure geometric figure.

DRAWING IN WARPS.

The Peruvian loom is in theory very simple. In the first paper the more obvious technical features were discussed at some length. The importance of equal tension on the warps, the function of the loom string in lessening the strain of weaving, the use of the tie-string in dividing the warps in equal groups, etc., were all more or less carefully considered. Mention was made of several skeins of warp yarn, apparently formed into what is known as a warp chain (Fig. 39), preparatory to adjustment in the loom strings or bars.

The probable method of this adjustment will now be considered (Fig. 40). It is one of the accustomed disappointments in archaeological research that certain links in the chain of evidence should be missing. We can only do what the palaeontologists do in supplying a missing bone: reconstruct from suggestion and probability, the missing part. In other words, make an explanation consistent with known facts and pertinent to the function to

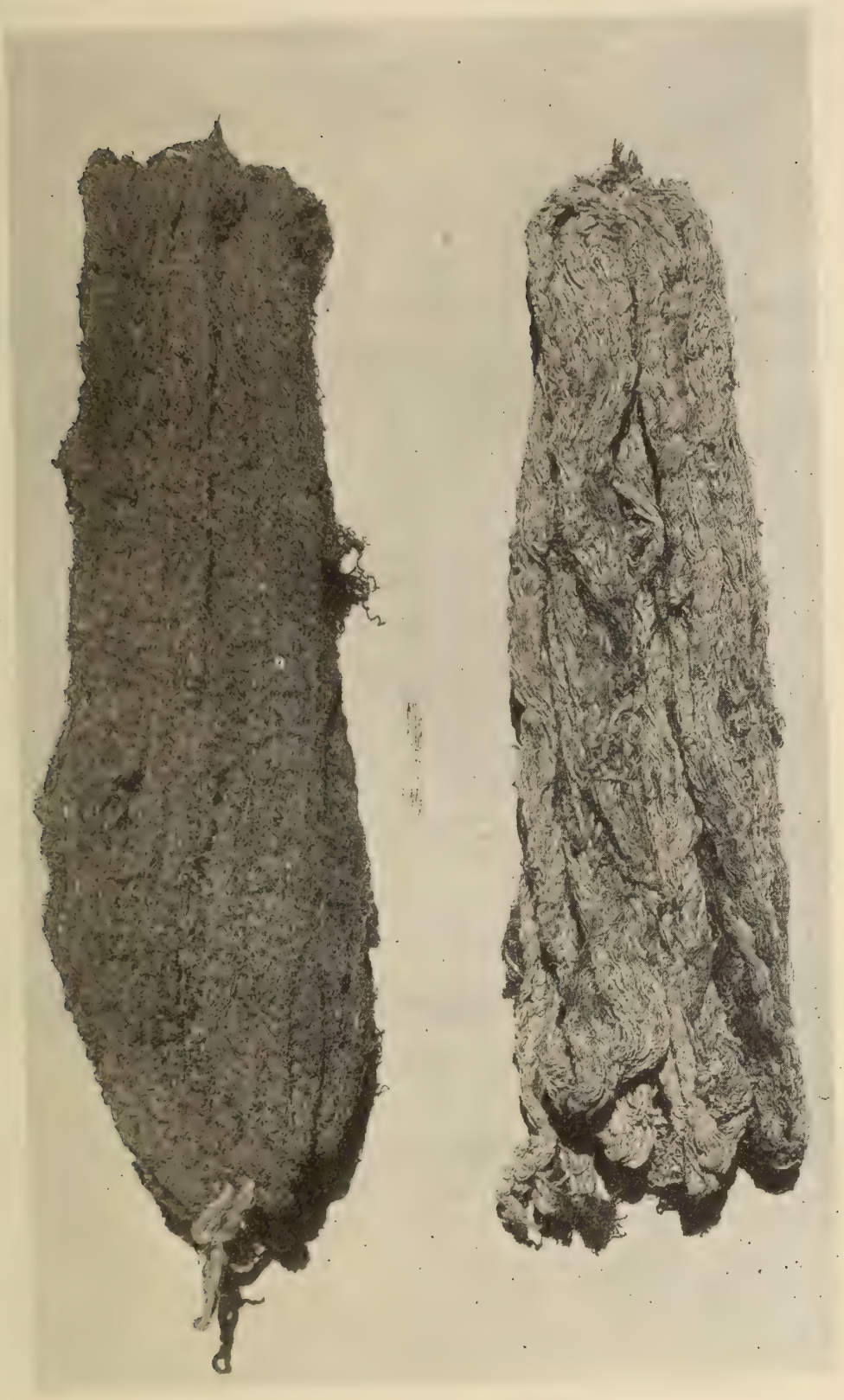

Fig. 39 (B–3781, 3782). Warp Chains.

be performed. We must bear in mind that simple as the processes of primitive textiles may be, they are nevertheless the result of the careful selection and elimination of mechanical evolution as truly as our more complex modern processes. We must look for and reject anything short of a continuous sequence of movement which neither more or less than explains the whole.

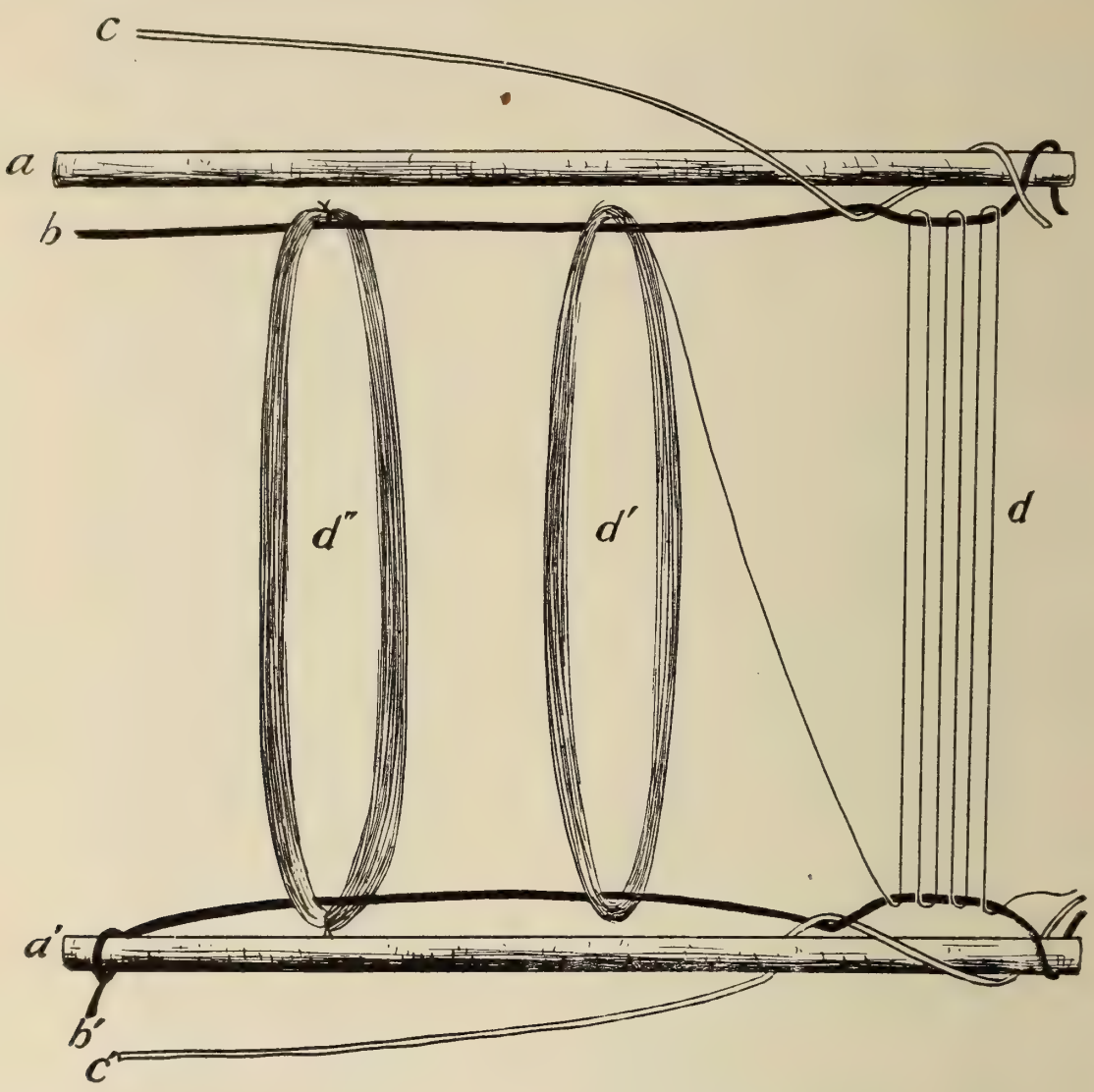

Fig. 40. Method of stretching Warps in the Loom. *a*, *a′*, loom bars; *b*, *b′*, loom strings; *c*, *c′*, tying string; *d*, *d′*, *d″*, warp skeins in different stages of adjustment between *a* and *a′*; *d*, warps in position for weaving; *d′*, partially used warp skein; *d″*, skein which has not yet been opened. The thread contained in these skeins is continuous.

In the small ribbon loom shown in the first paper, it will be recalled that the warps not stretched between the bars are drawn as though divided into skeins. This was done not only to show how tangles were prevented, but indicates the form in which warps were originally placed in the loom. This natural cohesion of approximately equal groups of warps is apparent in the two looms from Ica containing partially woven webs recently added to the collection (Fig. 10).

Drawing in warps is a very important part of weaving. These yarns must all be in place before the first weft is inserted. They form, as it were, the skeleton on which the fabric is built. The rules of good texture require that each square inch of web contains the same number of warp and weft as every other in the same web similarly decorated. It is therefore of prime necessity that the yarns which may not be either increased or diminished in number, nor moved in relative position, should be placed in correct division and order at first. If a single warp were out of place and crossed its followers, good weaving would be impossible.

There is also the matter of tension to be considered. The strain must be distributed equally on each end. This is not only to prevent breakage in weaving, but to insure good even cloth. A loose end would cause a pucker or a soft spot in the texture.

Therefore, the explanation of the skeins is as follows. Yarn intended for warp was looped over the sticks, probably thrust in the ground. The distance between them was the length of the web into which they were to be incorporated. As small amounts were thus treated, they were secured with string at the ends (Figs. 39 and 40). In this way the proper sequence was maintained and tangles were avoided. When sufficient of these hanks were formed, they were slipped over the loom string or bar. The skeins were thus treated in the order in which they were formed, each skein placed at a certain distance from its neighbor. Then the first skein was straightened on the portion of the loom it was intended to occupy. The small number of ends in each such unit, was easily arranged by the eye and hand of the weaver. The individual loops were placed on the loom in the same order as they had been wound on the ground stakes.

This orderly sequence was followed through the whole number of skeins, which for convenience, we call a warp chain. First the skeins were placed in the loom in the order in which they were formed; next each loop containing two warps was arranged in the order it was wound. It may be well to call attention to the fact that the warp in these fabrics is in reality not a collection of independent threads but a continuous length of yarn. At both ends of the web it loops back. In many fabrics which had loom strings, these loops can be plainly seen. Where loom bars were larger and left too long loops, many devices of weaving and darning were used to cover them up. Indeed, the effort to conceal these loops and protect them from wear was the impulse which directed the ornamental fringes and borders.

DISTRIBUTION OF TECHNIQUES.

There is a strong family resemblance between the textiles from the different centers of population of old Peru. The same fibers, practically the same color combinations and similar excellence in spinning, are characteristic of all the fabrics. However, there are certain minor details of design, varying degrees of excellence and a few apparently individual techniques, peculiar to the different localities. The collections in the possession of the Museum cover a large geographical area and are perhaps the most comprehensive in the world. Careful analysis and comparison of such comprehensive data should form an excellent basis for establishing the distribution of textile skill in this land. It seems unlikely that any really distinct weaves or fibers or designs peculiar to these ancient peoples should not be represented in this great amount of material. Still this possibility must be taken into account, and perhaps minor details may be modified by specimens in other museums, or among those yet to be discovered in Peru. Mr. C. W. Mead has given unsparingly of his time and knowledge to aid the writer in the technical examination of the Museum's great collection of cloth. It seems unlikely that anything of importance has eluded this investigator, still many interesting weaves were discovered almost by accident. For example, the important find of pile knot fabric resulted from an idle curiosity on the writer's part to learn the contents of a paper parcel, and in the two recent Juilliard collections distinct gauze weaves were revealed. It is therefore within the bourne of the possible that some interesting details may have eluded the search even in the Museum's collection. With full allowance for these exceptions it must be admitted that deductions made from so extensive a collection as the Museum's should be reasonably accurate.

The ancient centers of civilization adjacent to the modern city of Lima, were the most advanced in textile skill. Most of the finest pieces come from the localities of Ancon, Surco, Lurin, and Pachacamac. These places reflected the influence of the great Tiahuanaco. A comparison with the three Inca pieces, one of which was found in a stone chest on the Island of Titicaca indicates that even at the time of their weaving, the craft had degenerated from the ancient standard. There is perhaps too little material from the Inca period to establish this comparison, but the ponchos above referred to are so well known that it is justifiable to assume that if any other collection possessed pieces appreciably finer it would be a matter of record. The degeneracy is apparent in artistic merit as in technical excellence. The

wonderful simplicity of geometric art typical of the best work of the ancients, is here replaced by grotesque realism and a general lack of design balance. The colors, excellent in themselves, fall somewhat short of the perfection of the older pieces.

The artistic superiority of the Tiahuanaco school is evident when we compare it with the contemporaneous production of Nazca and Ica. In these later places very skilful, and at times original, technical processes were applied in creating symbolical figures, in which an attention to supposedly important detail, has somewhat detracted from the undoubted artistic merit of the color harmonies. In other words, their art is overshadowed by superstitious veneration for certain grotesque figures and the concept of beauty of pure form is lacking or rather in a nascent period. The line of demarkation between the two schools is by no means absolute for in the fabrics of the Tiahuanacan area occur symbolical delineations and in those from the deserts of Nazca and Ica are many in which pure geometric figures predominate. Yet the tendency towards emancipation from the influence of superstition is much the stronger in the former school and coupled with a marked spinning and weaving superiority established this area as the one in which textile skill reached its highest development.

Under the notes on the separate development of Ica and Nazca, will be discussed the individual techniques in which these places excelled. These exceptions by no means weaken the general theory and are no more than the expected results of a wide distribution of skill in a particular art.

The Museum's collection is very rich in examples of the tapestries of the different areas. A careful examination resulted in the following analyses.

Finest plain tapestry, B-1225, count 44, three-ply cotton warp and 280 two-ply vicuña weft. Location, Surco.

Finest figured tapestry, B-8536, 44 three-ply cotton warp and 200–220 two-ply vicuña weft. Location, Pachacamac.

Finest all cotton tapestry, 40 three-ply warp and 180, two-ply dyed cotton weft. This piece was very difficult to count because there is a dense nap on the surface, due perhaps to some form of teasing. The design is simple weft stripes. It comes from Nazca.

Finest tapestry in which wefts interlock at every change of color (Fig. 5), count 32 cotton warp and 84 two-ply vicuña weft. The warp runs double but for the weaving count, each pair has been treated as a single end. They are single-ply cotton and extremely fine. Location, Nazca.

This type of weave only occurs in the fabrics coming from Nazca and Ica. Perhaps the idea was suggested by the interlocking wefts universally used to close openings in tapestry. It may also be added that as far as I have observed, no all cotton tapestries occur in the vicinity of Lima.

The counts of the three Inca ponchos found in a stone chest on the Island of Titicaca are as follows: —

B-1500, 24 three-ply cotton warps and 112 two-ply vicuña weft.

B-1504, 36 warps and 138 weft.

B-1505, 40 warp and 142 weft.

One of these ponchos has been compared with the fine artistic web from old Tiahuanaco in the tapestry chapter.

The finest example of bobbin-weave is the decorative stripe in B-1225. This piece has been discussed at length under that heading.

The two examples of pile knot fabrics come from Pachacamac. B-813 is a beautiful light weight embroidered veil 28 by 28, single-ply 250 cotton, came from the same place as also did the only examples of maguey fiber webs (1-993). The counts are as follows, 60 warps, 36 weft, 88 warp, 40 weft, both two-ply maguey.

The finest example of double cloth, B-4660, was from Pachacamac. As this fabric was described in the chapter on double cloth it is only necessary to repeat that it contains 96 warp and 96 weft in each square inch.

The finest plain weave comes from Paraiso, count 112 two-ply warp by 48 two-ply weft, both cotton. B-5449, referred to under mechanical design, is the best specimen of warp stripe and comes from Ancon. Its count is 104 two-ply dyed cotton warp and 34 two-ply undyed cotton weft.

Few examples of tie dyeing occur, perhaps too few to make a comparison but the finest in the collection at least is B-4062. The count of this is by no means remarkable, 44 warp by 40 weft single-ply cotton, but the fabric is a very fine example of light crêpe and the dyed pattern most effective. It was found at San Isidro de Sayan.

Certain comparisons have been purposely omitted from this list. Some fabrics were so nearly alike as to offer no sufficient basis and others occurring only in Nazca and Ica will now be discussed under those heads.

The collections from Nazca and Ica are recent additions to the Museum, purchased by Mr. A. D. Juilliard. The brief list of the techniques does scant justice to the value of these gifts. However, the points of technical interest have been considered under their separate headings and a view of the actual fabrics alone can furnish a proper idea of their beauty. The following weaves occur in Nazca.

In the Nazca collection are tapestry, bobbin-weave, painted cloth, brocade, interlocking weft tapestry, embroidery, and the only examples of twilling found in all the collections. In this collection are two very interesting ponchos of rough cotton ornamented at the throat and border by embroidered bands of a species of chain stitch (Fig. 16). The technique is suggestive of the rare old Moorish embroidered carpets. These pieces are

remarkable for their wonderful dyes and many of their tapestries besides the cotton one above mentioned, fall little below the technical excellence of the pieces from around Lima. The most remarkable development is in brocading. Certain large shawls displayed in the Nazca case are completely covered with brocade figures.

Ica textiles bear a very close relationship to those of Nazca. Their technique includes all those of Nazca and a very remarkable application of embroidery to gauze fabrics. Besides these there are specimens of this technique on light and heavy weight which place this method of decoration as their principal mode of expression and perhaps as the finest type of the kind in all Peru. A method and a system which indicate many generations of creation and selection is very evident in their embroidery. This mode of expression has been relegated in our day to such a humble position that we lose sight of the fact that formerly it held a place in textile art second only to tapestry. In the possession of Mr. John Kimberly Munford is a very fine example of an old embroidered shawl from India. This web is covered so completely with needlework figures that the basic fabric is entirely hidden. There is, however, little if any method in the application of the decorative yarns and for that reason it is not such a fine technical example of this ancient craft as the Ica shawls which have been described and diagrammed in the chapter dealing with embroidery.

Perhaps some aid might be had in establishing the textile supremacy by a careful comparison of the yarn. This would be very unsatisfactory unless we could ascertain the natural advantages in the production of raw fiber peculiar to the different localities. Besides this, knowledge as to the existence of the cloisters and their influences on the craft would be desirable. From the available evidence, including the comparisons of the finest specimens, it may be said that the southern districts excelled in this as well as most of the other branches of textiles.

LITERATURE.

It is to be regretted that there exists so little technical writing on the general subject of hand spinning and weaving. Most writers dealing with these subjects naturally pay more attention to the historical and artistic qualities of the fabrics than to their purely mechanical qualities. The lack is particularly evident in the case of Peruvian textiles. To the early Spanish writers there was nothing novel or interesting in hand spinning or weaving. It was in the direct course of nature, just what they had seen every day at home. Slight differences of technique, so interesting to textile students, naturally made little impression on their minds. It must in fairness be admitted that the rich coloring and delicate texture of the actual fabrics were far from a matter of indifference to them or to the Spaniards who stayed at home. But their natural and commendable admiration for these handsome fabrics did not lead to a careful inquiry into the process of manufacture.

The careful German scientists have contributed two most excellent works on the woven material, but here as elsewhere the technical or rather textile problems, were either disregarded or relegated to the background. A work by Weiner in French entitled "Pérou et Bolivie" contains some fabric illustrations. By far the most careful work from a technical standpoint appears in an all too brief monograph by the learned Dr. W. H. Holmes entitled "Textile Fabrics of Ancient Peru" (Bull. 7, Bureau of Ethnology 1889). The only exception to be taken to this excellent paper is a slight confusion in the few textile terms and the lack of textile terminology. In other words, the writer approached the subject as a trained scientist, seeing clearly and writing as clearly what he saw; but naturally unfamiliar with the craft of weaving. Nothing could be further from the writer's purpose than to criticise so fine a work and the following remarks are intended merely to clarify Dr. Holmes' work for textile readers.

On page 7 appears the sentence: "No looms have been discovered," but almost in the next sentence a frame to stretch the warps is mentioned. Obviously, what is meant is that no complicated machine for weaving appears among the relics of Peru. The comparison with Coptic fabric at the top of the same page is in regard to tapestry, as the Copts had no such extensive technique as the ancient Peruvians.

On page 8, fig. 3 are illustrated a number of textile implements. It is not necessary to go into the matter at great length since the subject was

treated in the first paper of the series. H is a weave dagger, L a weave sword, K and I, doubler spindles. The object marked E is not among the numerous relics in the Museum's collection. From its similarity to the bobbins used in modern tapestry weaving, I should say it was a weft implement. Its diameter would prevent it from being used in the weaving of the finest Peruvian webs. It may have been employed in the manufacture of the coarser fabrics.

On page 12, the opinion is expressed that tapestry figures were woven separately and then the intervening spaces filled in. Such faulty method of weaving is indulged in by the Navajo. The result is that two sets of weft woven in at different times do not run in exactly parallel lines. Anyone familiar with Navajo blankets will recall the stress lines appearing in these otherwise excellent fabrics. The best Peruvian tapestries show no such unevenness. There appears to be little doubt that no matter how varied the colors and figures might be, weaving was carried entirely across the width of the warp at each pick, and the fabric grew steadily and evenly upwards, the width of one weft at a time. An apparent exception to this rule is noted in tapestry weaving in the discussion of eccentric weft.

On page 13, the closing of the tapestry slits by the rough expedient of sewing is suggested. The different weaving tricks employed to close these openings or to prevent their appearance, have been fully discussed in the chapter on tapestry in this paper and in that on weaving in the first paper. Fig. 8 therefore represents some mending or maybe what is called interlocking weft.

The great care taken in the compilation of this paper is illustrated when we find the author describing exactly the technical nature of intricate techniques, the very names of which are apparently unfamiliar to him. On pages 16 and 17 are descriptions which must refer to double cloth, single-faced bobbin-weave (a species of Jacquard) and what may be brocade, if we merely change the text so as to read "weft" in one place instead of "warp" in the paragraph beginning "Hardly less interesting." Mention is made of the piled rope described in the present paper, also reference which can only mean embroidery or gauze or *buratto*, and lastly, a description of tie dyeing and cloth painting.

In Miss Mary Lois Kissell's admirable work on "Aboriginal American Weaving" (Transactions, The National Association of Cotton Manufacturers, vol. 88, p. 196) there is no reference to Peruvian weaving. However, the technique of weaving in Mexico and the Southwest, especially Pueblo weaves and looms is apparently very closely allied with those of Peru.

While perhaps not entirely pertinent to this paper, some brief discussion

of the excellent monograph of Dr. Walter E. Roth on the textile arts of British Guiana may be of interest as showing one of the simplest forms of spinning cotton thread and also describing a very primitive loom. It will be observed that the entire processes are conducted without the aid of any implements except a spindle and a dish-like whorl of gourd, so light as to have no influence on the insertion of twist in yarn. No clearer idea can be given than the careful description of Dr. Roth: —

After the cotton [*yaho-(t)udai-a* = cotton tree] has been picked, it is put in the sun to dry, but for not more than a day or two. It can then be stored in a *quake*, or basket, where it may remain for any length of time, provided it is not allowed to get wet. When about to be put to use, the *débris* is carefully picked out, and the whole teased, bit by bit. This teasing process is important. A very small handful is pinched up, teased out with the fingers, "smacked," so to speak, between the flats of the hands (Plate I, Fig. 1), and thus alternately teased and sharply squeezed into a very thin circular pat about 4 to 4½ inches in circumference. During the smacking process there is a slight simultaneous rotation at the wrists. A large number of such pats are placed one on top of the other, forming a pile or, rather, cylinder about 6 or 7 inches high. This cylinder is then pressed laterally, folded in its length, and gradually stretched. It is again folded in its length and similarly stretched, so as to form a soft pad about 2 feet long. Such teased cotton is called *yaho-abuni*. The spindle, or *Kiro-hodóri* (Fig. 2), is made of a tapering shank (*tu-dai-a*) up to 18 inches in length passed through two circular discs of "calabash" (*tuburado*), which form a guard (Fig. 3). As often as not, the spindle will be seen to have wound on it some cotton thread already manufactured, which will now be attached and worked into one extremity of the pad. This bit of manufactured thread, however, does not lead directly from the pad of raw material to the spindle, but indirectly, by means of an intervening loop, around the nick at the extremity of the shank. The purport of the loop will soon be recognized. On the other hand, if the spindle has no cotton already wound on it, the latter is replaced by any other conveniently sized twine similarly attached to its extremity by loop, and so on to the pad. At any rate, the long pad of teased cotton is twisted into a spiral, loosely at the distal extremity, but progressively tighter towards its proximal, which is again stretched previous to the whole being lightly wound around the forefinger and wrist (Fig. 4), its distal end hanging loosely from over the fore-arm. That portion of its proximal extremity between the two thumbs is now gradually and very carefully teased out and stretched, any untoward slipping being prevented by resting the third finger of the right hand upon the bent fore-finger of the left, which acts as a sort of fulcrum. On completion of the stretching, the amount and exact degree of which will depend upon the thickness of ultimate thread desired, the portion of cotton just stretched is rolled with the right hand, at the same time that the tip of the spindle is twirled in a reverse direction with the left (Plate II, Fig. 1). Not only does the loop, already referred to, ensure this rotary motion being imparted to the thread, but it also prevents the thread itself becoming shifted or untwisted from off the spindle, when the latter is now left to hang loosely up against the spinner's thigh. Some more of the pad is unwound from off the arm, its proximal end again carefully stretched, etc., the spiral condition of the whole being retained and aided

in the act of re-winding it on to the wrist, and the spindle again twirled. The whole process, indeed, consists of these three factors successively repeated — the winding of the pad, the stretching of that portion of it between the thumbs, and the twirling of the spindle. The retention and tightening up of the twist in the portion of thread already manufactured is, of course, due to the rolling of the two thumbs, during the twirling of the spindle, being in opposite directions. When a convenient length of thread, say 18 inches or a couple of feet, has been manufactured, it is rolled taut on to the spindle (Fig. 2), the spiral into which its constituent fibres have been twisted being in the direction opposite to that in which the completed thread is being rolled." [1]

To Dr. Roth's excellent paper we are further indebted for a diagram of a very primitive loom. It has generally been assumed that lease rods were indispensable parts of a loom. Mr. Luther Hooper states this in his work "Hand Loom Weaving" and the assertion is often met with in other technical works. The purpose served by these rods is twofold, they divide the warp into equal parts convenient for the formation of sheds and they place them in the same plane. When warps are strung over loom bars, they naturally are opposite, not parallel to each other. In order that the weft may be interlaced, it is necessary that some method may be found that will place them in position for the operation of weaving. Since something of this nature is required it has been too hastily assumed that no true looms existed without lease rods. The diagram, however, shows a primitive loom, containing neither loom lease or heald rods. The warps are so few per inch that it is not necessary to separate them into two groups to aid the formation of sheds and placing them parallel on one plane and at equal distance from each other is accomplished by the peculiar darning of weft. Here are two wefts picked in slack and between each pair of warps twisted about each other. It will be readily seen that this first pair of picks transformed a mere loop of string over two parallel bars at once into a workable warp capable of being the foundation of a coarse plain cloth by the simple interlacing of weft.

The weave sword is shown forming a shed of this set of warps. Whether it was then used as a batten to beat up the weft is not mentioned. Of course, beating up is only indispensable in the weaving of very compact fabrics; a loose weave suitable for a hammock or as a container for large objects could be woven without this process. This must consequently represent a very early form of loom, the loom of the Peruvians representing a very considerable advance. In this latter type (described in the first paper) appear loom strings which, because of their smaller diameter than the bars, lessen the need of lease. Heald rods are used to form sheds, and the weave

[1] Walter E. Roth, "Some Technological Notes from the Pomeroon District, British Guiana" Part II, (*Journal of the Royal Anthropological Institute*, Vol. XL, 1910).

dagger as an extra beating up implement. These apparently simple devices must have occasioned great improvements in the art of weaving and when properly considered are as remarkable as any of the later textile inventions.

Plate IX in the same paper illustrates a method of obtaining fiber from a leaf. By confining the leaf in a slip knot and sharply pulling it, the outside soft matter was removed, leaving the fiber partially prepared for spinning. Perhaps the maguey fiber of the ancient Peruvians was prepared in somewhat similar fashion. However, this could by no means account for the fine heckling, but may serve as an indication of some initial process.

In the Sixth Annual Report of the Bureau of Ethnology, Dr. W. H. Holmes has given some very interesting additional notes on certain Peruvian fabrics. They are considered in their relation to the general subject of textile art. On page 211, fig. 309, is a drawing of a fancy gauze which, strangely enough, very closely resembles one of the fabrics chosen for illustration in the chapter on gauze in the present paper. Fig. 310 represents a fabric containing gauze stripe. On page 212, fig. 311 appears a sketch of embroidery on a gauze basis or *buratto* forming a border on what appears to be a plain web of cloth. Fig. 314 is an arrangement of tassels, the technical nature of which cannot be determined from the illustration. Figs. 334–335 represent the face and reverse of a double cloth charm. It is a characteristic design of a fish and resembles the one selected for diagram in the section on this type of weave. Its nature is clearly shown in this splendid drawing. Fig. 342 is a tapestry representing a human form and certain other conventional figures and was taken from Reiss and Stübel's "The Necropolis of Ancon." Fig. 348 is described as embroidery on net; this may mean gauze. A fine example of the painted fabrics is given in Fig. 350. Fig. 349 described as embroidery, has much the appearance of brocade but of this it is impossible to be certain without examining the actual fabrics. A very fine example of painted cloth is given in Fig. 350. This completes the Peruvian textiles in this work. Their nature has been clearly illustrated in the text and their philosophical meaning discussed in a thoroughly scientific manner. This slight addition of terminology should make them thoroughly intelligible to the textile student as well as ethnologists.

CONCLUSION.

The reasonable limits of such a paper have permitted a brief discussion of a number of technical methods of design. Perhaps some superficial exception might be made to the assertion that there is no method of decorating a web of cloth, but has a representation in Peru, for as can be seen, no mention is made of roller printing. However, in Colombia, and occasionally in Peru, clay cylinders were used to print the human body, so it may fairly be said that even this principle was understood. It must also be borne in mind that such a generality applies to the philosophy rather than the details of the craft. However, lest by qualification the force of the truth be impaired, it can safely be asserted that no single people we know ever invented and perfected so many forms of textiles.

A brief outline of the weaves described in this paper will emphasize this fact and be sufficient excuse for the repetition.

Tapestry
- cotton warp, wool weft
- all cotton
- interlooping weft

In reality, each device for closing the slits might be treated as a separate technique.

Embroidery
- on very light material
- on gauze
- on loose weave
- completely covering surface

Brocade
- self decorated
- plain

Gauze
- plain
- fancy
- as basis for embroidery

Plain weaves, weft stripes, warp stripes, checks or ginghams, warp figures, and twills.

Double cloth

Pile knot { in fabric / in ropes or cords

Lace { in bags / in fabric

Bobbin-weave { on one surface only / both surface and reverse

Tie dyeing

The question naturally arises which of these techniques was the first, and in what order did the others follow? Only a very general idea can be given of such a subject and certain unknown conditions in different areas would modify details of perfect sequence in others. We must consider the different types with regard to technique rather than design, and passing from the simple to the complex, the conclusion will be reasonably accurate.

The earliest textiles were intended for ornamentation not as an aid to modesty nor as protection from the elements. The weave was a plain interlacing of warp and weft. The use of dyes was understood before textiles. Peoples very low in the cultural scale paint their bodies in grotesque figures. It is almost certain that some form of painting must have been applied to the first weaves. The early accounts of the crude textiles of the Eastern Indians speak of painting. Savages seldom leave undecorated any of their personal belongings.

Bags so closely resembling baskets, except that spun filaments take the place of reeds or grasses may have been the earliest form of weave. Belts also, appear in many tribes by no means famous for their weaving skill. Many tribes weave bags of excellent texture and apparently know nothing about other textiles. The fondness of savages for these two useful and ornamental forms of weaving may indicate the earliest use of weaving with spun thread.

Embroidery is perhaps the earliest mode of ornamenting a woven fabric by the use of decorative thread. The habit of sewing shells, teeth, and other small objects to fabrics would naturally suggest the use of the sewing yarn without the objects as a means of adding a touch of color. The first form of true woven design was unquestionably tapestry. The simplicity of this is so obvious that a child could understand it. It can be done on the most rudimentary loom neither lease rods nor healds being necessary. In fact, a form of tapestry could be made without even the batten or weave sword. Examples of peoples such as the Navajo and Chilkat, familiar with

no other textiles, with the possible exception of warp decorated belts among the former, who weave excellent tapestries, are not wanting to emphasize this simplicity.

Both embroidery and tapestry are very ancient, local conditions determining priority in certain areas. In Peru both forms reached a very high development. In different geographical areas one or the other form predominates. The fact that embroidery occasionally follows the mechanical limitations of tapestry figures with a fidelity not required by its more facile technique does not indicate that tapestry was first, but merely reflects the predominating influence of textile ornamentation.

The next logical development would be the application of the colored yarns to mechanical design (Fig. 37). The introduction of heald rods as shedding devices would hasten this technique. The use of two or more colors of warp and weft would, at a much later period, suggest the combination of the same colors of warp and weft in double cloth. In fact, some Peruvian webs are part stripes and checks and then the fabric changes into a double cloth with only the addition of an extra weft.

In what sequence, gauze, pile knot, and tie-dyeing appeared there is no way of estimating. The mere predominance of one technique might only indicate a preference, and this preference might be expressed for the latest invention. The scarcity of the others might mean degeneracy as easily as incipiency. However, of these three, gauze is the most common and most highly developed.

Brocade and bobbin-weave are closely allied to embroidery and probably are of later development. Before brocade could reach much vogue, textile skill must have reached a height which made the weaving of close even webs common. For without this basis, the brocade yarns could not be forced to the surface in beating up. Bobbin-weave is so often found and of such great excellence, that it is very difficult to assign it any but an early place in the history of textiles. It is also a common method of decorating baskets or mats. Yet, the great difficulty of applying this method to fabrics composed of fine spun threads and the amount of forethought required to produce design, seem to indicate that it was the fruit of centuries of textile experience.

Attention has been called to the similarity of Peruvian with Asiatic design figures. The general explanation has been that two races weaving fabrics for great periods of time must arrive at great similarity of figures even without the influence of cultural relationship. The fact, however, that Egypt equally ancient, and for centuries using the same type of loom, achieves no such resemblance must somewhat weaken such a theory. In fact, Egypt practically never advanced in textiles from the simplest methods

until the comparatively modern introduction of Coptic influence. Even though we cannot account for the similarity of design in South America and Asia, we must still admit that it exists to a remarkable degree.

There are certain forms of textiles that are practically universal, such as tapestry and embroidery. The appearance of these fabrics in widely separated parts of the globe can be of no significance. They are so simple and arise so spontaneously from the practice of weaving that independent development is not only possible but the natural thing to expect. It is a question, however, if a like easy explanation can be accepted for such complicated techniques as gauze, double cloth, and tie dyeing. Brocade and bobbin-weave are excluded from this discussion because the former is a natural development of embroidery and the latter is so common in basketry. Pile knot, however suggestive, is eliminated because the technical relation is scarcely as significant as is the mere surface appearance although it may be an interesting speculation to say that two techniques having as a result such similarities of appearance could not be totally unrelated, but such reasoning leads into too many pitfalls.

But the three mentioned fabrics and especially gauze and tie dyeing are at once so original in conception and so similar in both Asia and Peru as to force themselves into notice. Could the human mind have twice stumbled on such unique construction? Can this resemblance, so singularly emphasized by a strong artistic likeness, be merely an intellectual accident? Even admitting that many textile designs and processes were simply copied from the more primitive form of basketry, does not this admission merely change the issue from weaving to basketry?

When we look at the immense amount of literature devoted to Asiatic rugs and to European tapestry, two rather simple technical expressions of the weaver's art, it must be evident how little can be hoped for from so brief a paper dealing with so many and so complex forms as this. We have been so long accustomed to regard Asia as the fountain head of textile knowledge that perhaps sufficient attention has not been drawn to the skill and science displayed in our own hemisphere. This is to be regretted, since the ancient inhabitants of this half of the globe developed a technique and an art which more than repays the effort necessary to its comprehension. While Peru stands far in advance of any other race, still many peoples such as the Hopi, and Huichol, were very excellent craftsmen. The weaving of fabrics by machinery is a thing of but yesterday, the art of the hand loom reaches back into an antiquity almost contemporaneous with the antiquity of the human race. A thorough study and proper appreciation of the knowledge stored for centuries in the ancient graves cannot fail to be of immense value to all interested in the development of the modern industry. Painters, archi-

tects, and engineers are not ashamed to learn from the ancients, surely weavers should have no scruples.

Weaving is the most ancient of the great arts. It is still, next to agriculture, the largest industry in the world. At the very dawn of man's history it appears, and has continued down to our own time, a thing inseparable from true culture. Man's ideas of beauty have been fostered and gratified by its products, his ingenuity has been exercised and his comfort enhanced by its agency. From the rough fish weirs to the most elaborate baskets, from the coarser fabrics of flax to the gossamer webs of cotton and silk, it has sustained and beautified his life from the night of history to the latest passing hour; it is the veritable nurse of civilization.

Peru's part in the world's textile development, had her skill and knowledge been available at the proper time, would have been immense. The accidents of history which either prevented her taking this part or prevents us from knowing that this glory is justly hers, cannot detract from the proof of her intellectual greatness, predicated by such great development in so intricate an art. Her isolation forced her to travel the long road alone. From the roughest wattling, the mere interlacing of twigs and stakes, up to the finest of woven webs, composed of the most delicate filaments human hands ever formed, each painful step was directed solely by her native genius. Surely unless all records of human progress have been incorrectly appraised, this must have taken immense eras of time. These beautiful and faultless examples of this prehistoric art must as certainly point to great antiquity as the most venerable relics of Egypt or Asia.

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CONVENTIONALIZED FIGURES IN ANCIENT PERUVIAN ART

BY

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CONVENTIONALIZED FIGURES IN ANCIENT PERUVIAN ART.

By Charles W. Mead.

PREFACE.

In the preceding sections of this volume my associate, Mr. M. D. C. Crawford has made a searching analysis of Peruvian textile technique. This paper is given to an analytic discussion of textile and pottery designs from the same source. It does not exhaust the subject, but presents the results of such observation as the writer's curatorial duties permitted.

The greater part of the material for this article was collected in 1905. Since that time a portion of it has appeared in contributions to the Anniversary Volumes presented to Professor Franz Boas and to Professor Frederic Ward Putnam and in a paper on "The Puma Motive in Ancient Peruvian Art" read before the Nineteenth International Congress of Americanists at Washington, D.C., December, 1915.

The matter here presented is based on a study of objects in the prehistoric Peruvian collections now on exhibition in the American Museum of Natural History, and from these, with a very few exceptions, the sketches used as illustrations have been made. Credit has been given for those taken from other sources.

August, 1916.

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INTRODUCTION.

In the artifacts from prehistoric Peruvian graves the art student, whether painter or designer, finds a wealth of color schemes and conventionalized designs such as exists in few if in any other fields; and this is particularly true in regard to the textile fabrics and pottery vessels. In their decorative art the ancient Peruvians made use very largely of such objects and scenes as were familiar to them in their daily life, a large range extending from representations of the human figure to inanimate objects. While these representations are often very realistic, by far the greater number are more or less conventionalized.

Before entering upon a study of their art it may be well to say a few words concerning the country occupied by the people whose work is under discussion. Ancient Peru, at the time of the Conquest, comprised not only the region included within the present Republic of Peru, but also the greater part of Ecuador and Bolivia, and extended southward as far as the Maule River in Chile and was about half the size of the United States. Within these boundaries had lived and passed away, in prehistoric times, many tribes or peoples of whom we have little or no definite knowledge. Sir Clements R. Markham says:—

> During cycles of centuries the natives of the Andean region were slowly advancing toward the highest type of civilization of which their race is capable. Ruined edifices of unknown date and origin built of enormous stones seem to point to a period when a powerful empire existed in Peru, long before the rise of the Inca dynasty. Tradition barely reaches to that remote past, and the ruins are almost the only witnesses to the existence of a forgotten but once mighty dominion. Its epoch may be distinguished as the megalithic period and its remains are met with throughout the length of the Peruvian Andes.[1]

Sir Clements instances the ruins at Tiahuanaco, and Sacsahuaman above Cuzco, the remains at Ollantaytambo, Concacha near Apurimac, at Huiñaque, Chavin, Huaraz and Quecap (Kuélap), in Chachapoyas.

In studying Peruvian archaeology, it must always be remembered that the Inca were in possession of the coast region of the country but a comparatively short time before the arrival of Pizarro, and that a large part of the objects in museum collections was the work of their predecessors, generally spoken of as the megalithic people. The builders of Tiahuanaco

[1] *A History of Peru*, Chicago, 1892, pp. 17–18.

were of the megalithic people and their art is found to the northern confines of the Empire. In many localities the decorative motives of Tiahuanaco are found. The conventionalized puma head is a good example (Plate V, Figs. 15, 17). Fig. 15 represents the belt on the central figure on the great gateway at Tiahuanaco and Fig. 17 is part of a pottery vessel. Compare these with the two puma heads from Pachacamac (Figs. 18, 19). Fig. 13 is also from Pachacamac and here the two puma heads are connected by curved instead of straight lines as in Fig. 15. As has been said we find the forms and decorative designs of the megalithic people in widely separated localities, and generally differentiated to a certain extent in each place, as would naturally be the case.

The most important work that now confronts the Peruvian archaeologist is the determination of the different epochs through which Peruvian civilization had passed in prehistoric times, in the various culture areas. This can only be done by very careful and scientific excavations in the burial places. Too many of the collections in museums have been dug up haphazard and there is nothing to show whether a specimen was found near the surface of the ground or twenty feet below it. The locality from which it came is known, but nothing more. Now, there may have been near the surface a layer of Inca pottery, and below that a layer of older ware, and perhaps other layers still older and deeper in the ground; but the excavator was only after pots and mixed them indiscriminately together thus destroying a page in the history of prehistoric Peru.

During the last few years the importance of scientific excavations in determining the chronology of the different peoples who have inhabited Peru in the past has been better understood, and a good beginning has been made in this line, particularly by Dr. Max Uhle, at Pachacamac, Moche, Nazca, etc. It will require years of this serious research work before the relative age of each type of pottery can be known with any degree of certainty.

Many of the Peruvian textile fabrics are of great artistic beauty, due to the purity and richness of their colors, and the harmonious way in which these have been brought together. The strange conventionalized animal figures with which they are usually covered, while giving an added pleasure to the eye, serve also to give them a distinctive character of their own. The number of students, often large classes from various art schools, who now make use of the Museum's exhibit of these textiles in their studies of color schemes and conventionalized designs, shows that their value for this purpose is extensively recognized. Second only to the textiles, are the pottery vessels. Many of them have fine lines and are very artistically decorated in colors.

This paper deals with conventionalized designs. Those interested in the purely art side of the work of these prehistoric people are referred to the remarkable publications of Reiss and Stübel[1] and Arthur Baessler[2]; the first named for textile fabrics, and the second for pottery vessels and feather-work.

We know that the development of Peruvian civilization had been a very long one and that decorative art had reached a high degree of perfection before the country came under the sway of the Inca. Therefore, although the art of this region had passed through a number of periods, the present state of our knowledge makes it unprofitable to treat the subject otherwise than as a whole, and it may be roughly summed up under four heads, as follows: —

1. *Realism.* Representations of scenes and objects, animate and inanimate, familiar to them in their daily life.

2. *Conventionalism.* Conventionalized forms, mostly of animals, and parts of such forms, in which the degeneration does not appear to have been carried to the extent that the identity is wholly lost.

3. *Symbolism and Mythology.* Anthropomorphs, fish, birds, dragons, serpents, and other figures probably having a religious significance.

4. *Geometric Figures.* Scrolls, meanders, frets, and other geometric figures, most of which seem to have originated through the technique of basket work and are common to the decorative art of many peoples.

Realism was the chief characteristic of their art; and even in the textile fabrics, where the most highly conventionalized forms naturally occur, realism is apparently never entirely lost sight of; the kind of animal intended to be represented is still recognizable. I use the word "apparently" advisedly, as it is, of course, within the bounds of possibility that any of the numerous geometrical figures may have represented to the mind of the artificer some animal form.

Of the various theories that have been advanced concerning the origin and development of art, the one that appeals to me as being the most natural, and the one that seems to apply exactly to Peruvian art is that of "progress by degeneration." This theory was first formulated and clearly set forth by Professor F. W. Putnam in 1879.[3] His "Conventionalism in Ancient American Art"[4] followed a few years later. This latter contains a passage which seems to me so applicable to Peruvian art as we know it, that I give it below. He says: —

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[1] Reiss, W. and Stübel, A., *The Necropolis of Ancon in Peru*, Berlin, 1880–1887.
[2] *Ancient Peruvian Art*, Berlin, 1902–1903.
[3] *Papers of the Boston Society of Natural History.*
[4] *Bulletin of the Essex Institute*, 1886.

Thus it is that we find in the lower stratum of human development many cooking-vessels, water-jars, dishes, and other utensils made of clay, that are of the same form and style of ornamentation; but after the particular form of vessel desired was attained, and the early methods of ornament by finger-marks, indentures, scratches, cross-lines, and the imprint of cord or fabric, had been carried to their full extent, one can easily understand that something higher would follow. This advanced step is represented in various ways by different prehistoric peoples, but it is when this step is taken that the imprint is given to the art of each.

Among other ways, this higher expression seems to be shown in the realistic representation of inanimate and animal objects, often of a mythological or historical character. In the course of time, as art attained increased power of expression, it progressed beyond mere realism, and led to the representation of an object by certain conventional characters, without that close adherence to nature which was at first necessary to a clear understanding of the idea intended to be conveyed. Thus conventionalism began. Side by side with this conventional representation of objects are found realistic forms; conservatism, which is such a strong characteristic of primitive peoples, leading to both methods of expression at the same time (pp. 155–156.)

An almost ever present factor in Peruvian decorative art are the geometrical designs which owe their origin to the technique of basketry; to the interlacing of twigs, grasses, roots, vegetable fibers, etc. These designs were later copied in decorating all classes of objects and are particularly prominent in pottery vessels and on cloth. In the latter they form quite a part of the mass of decoration by serving as connecting links to the conventionalized animal figures, and often as parts of the animals themselves. They are also used separately to balance the composition.

We are studying the decorative art of a people who had no written language, and whose descendants retain little or no knowledge that can be of assistance to us. The ancient Peruvians have left us a wealth of material in the remains of their structures and in the contents of their graves; and what is revealed by these, together with such meager information as has been handed down to us by the early writers, constitutes our entire knowledge of this people.

In viewing a collection of Peruvian antiquities the visitor's first question almost invariably is "How old are these things?" This question cannot be definitely answered, but this much can be said: that all antedate the Conquest; that they vary greatly in point of age, covering a period beginning in dim antiquity and extending down to the time of the advent of the Spaniards under Pizarro in 1532. Internal evidence of the best kind is not wanting to prove that man had lived and toiled in this region for a great length of time. Inside the wrappings of the mummy bundles, in cloth bags hanging from the necks of mummies, and in vessels of pottery and gourd placed with the bodies in the graves, we find Indian corn or maize (*Zea Mays*)

which had been brought to a very high state of cultivation. Botanists tell us that this could have been accomplished only by careful and systematic labor during many centuries. Alphonse de Candolle [1] remarks: —

> Men have not discovered and cultivated within the past two thousand years a single species which can rival maize, rice, the sweet potato, the potato, the bread-fruit, the date cereals, millets, sorghums, the banana, soy. These date from three, four or five thousand years, perhaps even in some cases six thousand years.

Robert E. Coker, lately Fishery Expert to the Government of Peru, while writing of the great shell-heaps and islands and causeways of shells in the estuary region of the Gulf of Guayaquil says: "A thousand years of the present oyster fishery would not leave a trace comparable to these." [2]

The greater part of all Peruvian archaeological collections comes from the coast region which is for the most part a barren sandy desert where rain is all but unknown. The only inhabitable places were the fertile valleys of the small rivers rising in the Cordilleras and flowing into the Pacific Ocean. In these valleys they lived and usually buried their dead outside in the desert where the dry nitrous sand has so perfectly preserved them and the articles placed with them. So well are many of the textiles preserved that they are as strong and their colors apparently as bright as on the day they were taken from the primitive looms. Many pieces of cloth, especially those in tapestry, show great skill in weaving and a fine sense of color effects. Indeed if we judge these productions of the ancient looms by present-day standards we shall be forced to admit that for fineness of workmanship, beauty of designs, and artistic management of the colors, they have never been surpassed.

In the products of their looms we have another evidence of the antiquity of man in this region; for it was a very long step indeed from the first attempts at weaving to the production of such beautiful fabrics as have been found in the Peruvian graves.

Throughout the coast region the decorative motives oftenest employed are derived from the human figure, fish, birds, and the great cats; and these four forms will be considered separately.

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[1] *Origin of Cultivated Plants*, New York, 1902, p. 451.

[2] "The Fisheries and the Guano Industries of Peru," *Bull. Bureau of Fisheries*, Vol. XXVIII, Washington, 1908.

THE FISH IN ANCIENT PERUVIAN ART.

The fish as a symbol and as a decorative motive has played a prominent part in the religions and arts of many peoples. Thus we read: —

> The Fish was the earliest, the most universal of the Christian emblems, partly as the symbol of water and the rite of baptism, and also because of the five Greek letters which express the word Fish form the anagram of the name of Jesus Christ.[1]

In the various arts of the prehistoric peoples of the Peruvian coast region, numerous species of fish and their many conventionalized forms are of very common occurrence. They are either absent or at least only occasionally to be met with in other parts of the country. Pottery vessels were often modeled into fish forms, or decorated with fish painted or in relief. Wooden vessels in this form are numerous, as are also fish forms cast or hammered in gold, silver, copper, and bronze.

It is not uncommon to find painted representations of fish on cloth, particularly on such large coarse pieces as were often used to cover the mummy bundles; but these painted representations are few compared to the great number of conventionalized forms where the fish motive, in various colors, enters into the woven fabrics.

That the prehistoric inhabitants of the coast region of Peru should worship the sea would be natural and in accordance with what we know of other peoples similarly situated and in a like stage of development. The fish would be the natural symbol of the sea, and the frequency with which it appears in all the arts of these peoples would certainly indicate for it a religious significance.

Garcilasso de la Vega, in his chapter entitled "Of the Idolatry and Gods which the Ancient Incas adored, and Manner of their Sacrifices," tells us: —

> The Inhabitants near the Cordillera worshipped that Mountain for its height, those of the Coast made the Sea their God, which in their language they call Mamachoca, and is as much as to say the Mother Sea; the Whale for its prodigious bigness was in no less Veneration than the rest, and every sort of Fish which abounded amongst them was deified, because they believed that the first Fish in the World above them takes always care to provide them with a number of the like sort or species sufficient to maintain and nourish them.[2]

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[1] Mrs. Jameson, *Sacred and Legendary Art*, London, 1866, vol. 1, p. 24.

[2] *The Royal Commentaries of Peru*, Ed. Rycaut, Book 1, Chap. 4.

Among the woven fabrics the greatest number of conventionalized figures are found in the vicuña borders of ponchos and in such long, narrow pieces of cloth as were used as headbands, belts, etc. In these the fish motive occurs much more frequently than any other. The head is triangular, and its identity not to be mistaken by any one at all familiar with the fish figures painted on cloth, or represented in relief on pottery vessels. The other parts of the design are usually so arranged as to suggest the outline of a fish, as seen from above.

In the woven designs we almost invariably find the pattern to consist of two fish, turned in opposite directions, making what we may call the "interlocked fish design," with the whole so arranged, as I have said above, as to suggest the outline of a fish as they commonly represent it (see Plate I, Figs. 5–7).

Where such a wealth of material exists, it is difficult to make a selection; but I have endeavored to picture such as might perhaps be called types of a class, and in the textiles, where their decorative art reached its highest development, to show some few of the steps by which the realistic representation of fish may have degenerated into highly conventionalized forms. No one at all conversant with the subject would attempt to follow step by step the degeneration of an animal figure in any field of prehistoric art.

The series of fish figures, or any other series that may be given later, representing different stages of degeneration is not presented as the actual progression in conventionalization, but in the belief that the figures will lead to the recognition of the animal represented even after degeneration has run its full course and left but an almost unrecognizable skeleton, at least beyond identification by anyone who had not seen it fading away by stages from a more realistic form.

In cases where it is evident that an attempt at realistic representations had been made, little need be said. It is with the conventional forms of their higher decorative art that I shall concern myself at present, and trust that I shall be able to show that many of the designs which have hitherto been described as animal figures, designs derived from animal figures, and the like, are, in fact, conventional fish forms.

In the attempt to establish the correctness of my identification, I shall begin with such figures as are unmistakably derived from fish, and, by calling attention to some intermediate forms I hope to carry the eye, step by step as it were, from those that depart but slightly from the realistic to the higher forms.

Plate I. Fig. 1 shows a small wooden vessel in fish form, the cavity was undoubtedly used to rest the end of the spindle in while it was being twirled. Small vessels of pottery and gourd are similarly used today.

Fig. 2 is from a large piece of coarse cloth which formed the outside wrapping of a mummy bundle. The figure is painted in black, except the openings at the gills and the fins, which have been left white, the color of the cloth. The fish is represented as seen from above, the six white squares in the center representing a dorsal fin.

Fig. 3 shows another painted design from the covering of a complete mummy bundle. In this a decided change has taken place. The curved lines representing the gill-openings have become straight lines and parts of the body are represented by zigzags making the projecting points which are so characteristic of most of their conventionalized forms of animals, particularly of the bird and fish.

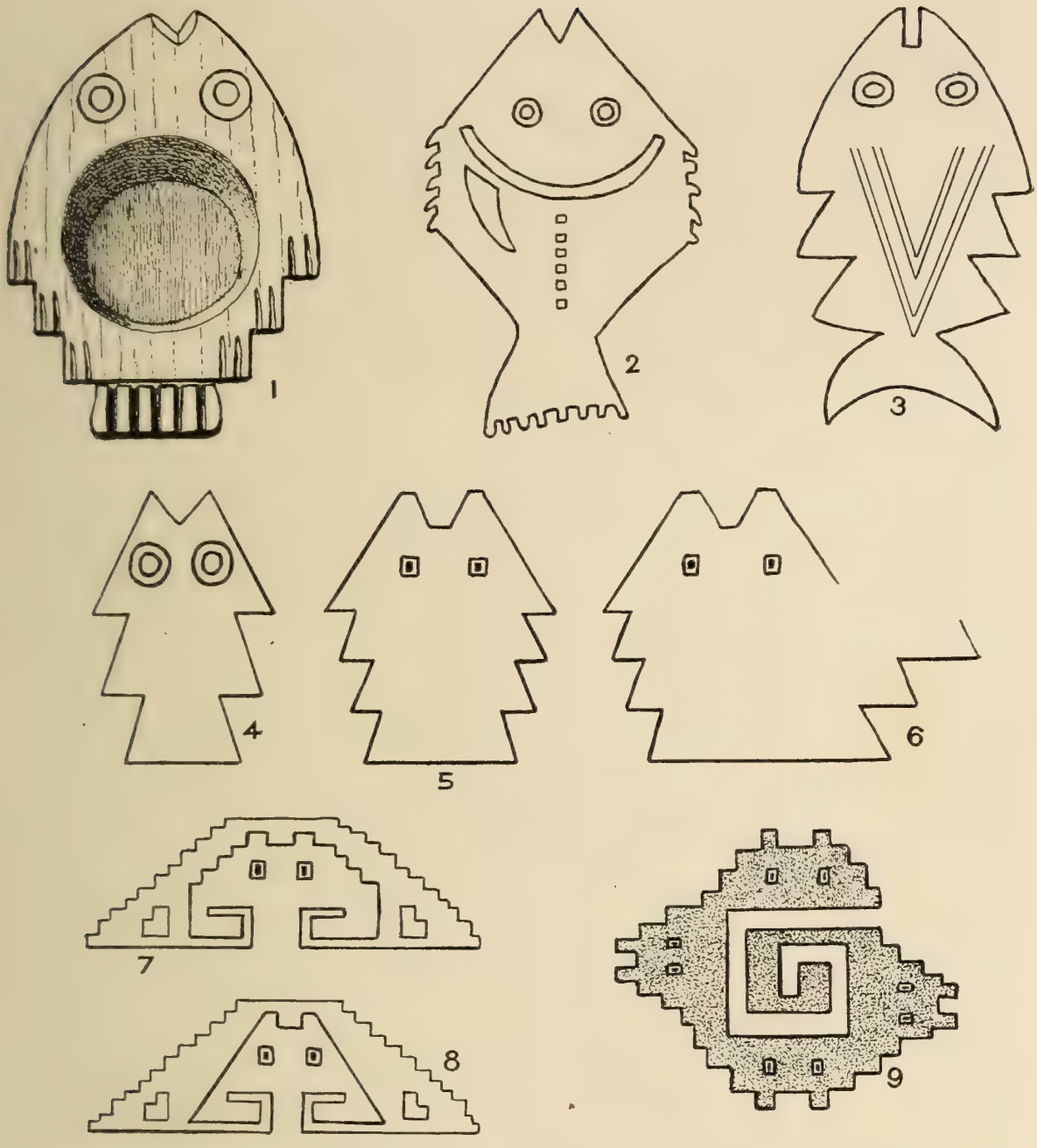
Fig. 4 is from a long belt or sash of vicuña cloth. The figure is repeated a number of times in different colors and is part of the woven fabric. Although unmistakably a fish, the degeneration has proceeded to the extent that nothing remains but the general form, eyes, and the characteristic projecting points seen in Fig. 3. In this figure, together with Figs. 5 to 9, I think we have the key to all the higher conventional forms of fish designs shown in the illustrations.

Fig. 9. Here we have a design consisting of four colored fish heads with a fret in white in the center. To satisfy ourselves that these are conventionalized fish forms we have but to examine the two sketches, Figs. 7 and 8. Fig. 7 is from another piece of cloth, but is the same form. If we draw straight lines from the mouth downward, to eliminate the step form arising from the technique of the weaving, the result is shown in Fig. 8. We now have exactly the same head as in the other fish figures above. These step form lines in woven fabrics often disguise a form which if drawn in straight lines would be recognized immediately.

Fig. 10 is a section of a vicuña border of a poncho. It shows what we call the interlocked fish design, which in some one of its great variety of forms is oftener to be met with on these borders than any other form of ornamentation. In this example the black fish is interlocked with one of red. These two colors form one of the diagonal bars in the design which will be presently described.

If we have any doubt that these interlocked figures represent fish forms, Figs. 5 and 6 will dispel them. Fig. 6 is a tracing from the black fish in the design. The two sides cannot be symmetrical as the line on one side of each fish must be carried away to form a part of the next fish to the right or left. In Fig. 5 the right hand side of Fig. 6 has been made to correspond with its left side and this gives an undoubted fish.

I will here call attention to an important feature of Peruvian decoration that applies particularly to these vicuña borders. This is a rhythmic



The Fish.

repetition of six units, each being of the same size and design, but varying in color. Commonly each square, band, or diagonal bar, or any other form constituting a unit, is different in color or colors from the one preceding and the one following it; but it often occurs with three all colored alike, followed by three in some other color, also alike, four of one and two of another, etc. In whatever way these units are arranged, the next six will be a repetition of the first series, and so on indefinitely. In another place I have described and illustrated this feature of their art.[1]

Plate II. Fig. 1 shows a very common fish design on borders, belts, etc. During years of almost daily contact with students of design, who have drawn from the Museum's collection, I have seldom known one to see the fish motive in this form until pointed out by sketches like Figs. 7 and 8 on Plate I, when it was immediately recognized. The step form lines of the weaver led them astray, and prevented their seeing the true character of the design, which they considered a purely geometric one.

Figs. 2, 3, and 4 have the whole design in one continuous line with the exception of the eyes. The interlocked fish heads are apparent in Fig. 2. In Fig. 3 they are triangular, like those of Figs. 6, 7, 8, 9 and 13. In Fig. 4 we have the familiar head and a part of the sides of each fish.

Fig. 5. Here is shown the same form of fish head shown on Plate I, Figs. 5 to 10. This is another very common decoration on borders, belts, etc.

Fig. 6 is from a belt or sash eight feet long and two and a quarter inches broad. The sketch shows only two complete units of the six-unit design which extends over its full length. The ground color is deep red and in this piece the lower fish figures of each pair are in dark yellowish-green. The upper ones, interlocked with them, are of the following colors: white yellow, pink, white, yellow, and pink. This makes the six units of the design. Where the character of a design left considerable areas undecorated, these were commonly filled in with a figure or part of a figure, generally highly conventionalized, of the same animal represented in the decoration. This sketch shows four such figures, two filling undecorated spaces above the main design, and two below it.[2]

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[1] "The Six-Unit Design in Ancient Peruvian Cloth," *Boas Anniversary Volume*, 1906.

[2] I shall always remember a pleasant incident connected with the drawing of this figure some ten years ago. I had but just finished it when a well-known anthropologist came in. He looked at it and said: "The design is certainly the interlocked fish. Now you know and I know that those figures that look like stone arrow points above and below are conventionalized fish, but how will you convince people who are unacquainted with such matters that they are fish?" Then I showed him a poncho of alpaca wool with the embroidered design of a pelican holding a fish in his mandibles (See Plate IV, Fig. 1). He looked at it, saw that the fish the bird had caught was identical with those in my drawing, and said with emphasis: "That settles it."

It will be seen that each pair of interlocked fish is connected with the next pair by an extension from the tail, consisting of a form bounded on one side by a straight line and on the other by a zigzag. This was a favorite device, as it gives a connected appearance to the whole design and balances the composition by filling space, where something is needed.

Fig. 7 is a gourd bowl about six inches in diameter, with the design burned in. Examples of decoration by pyrography are numerous in any large collection from the coast region, and it was the medium commonly employed on gourd vessels, many of them showing work of no mean order. In this interlocked fish design, although the workmanship is crude, we have again the triangular head, with the other parts represented by a straight line and a zigzag. A number of the fish forms with triangular heads are shown on this plate.

Figs. 8 and 9 represent two forms in relief, on pottery vessels, and show their fondness for the interlocked design.

Figs. 10–14 show fish forms common on pottery vessels, sometimes painted, but oftener incised or in relief.

Figs. 15–27 are forms of fish woven or painted on cloth, painted on grave tablets, and most of them will also be found on pottery vessels, with a great variety of modifications.

As I conclude this description of the designs on the two fish plates it comes over me that the number of figures shown gives but little idea of the vast variety found in the Museum's collections, where the fish is used as the motive. I trust, however, that a sufficient variety of the forms has been shown to give a pretty good idea of the character of this side of Peruvian art.

I do not claim to have discovered in these designs any series representing an historical sequence. My object has been to show to what extent fish forms appear in all the arts of the prehistoric peoples of Peru, and to attempt the identification of the conventionalized figures.

THE FISH.

THE BIRD.

The bird as a form of decoration was in great favor with the Peruvians, and many different kinds are represented in an endless variety of conventionalized forms on cloth, pottery, metals, wood, bone, gourds, and stone. Notwithstanding that the bird appears oftener as a decorative motive than any other, it has suffered less in the processes of degeneration than its great rivals, the fish and cat, or even the human figure. It never seems to have reached a stage where it is not easily recognized, or could be mistaken for any other animal, or a purely geometric figure.

Plate III. Figs. 1–4 show parts of four scrolls each terminating in a bird's head, probably representing the king vulture. No. 3 is painted on a grave tablet, the others are painted on pottery vessels.

Fig. 5. The light part of the design represents yellow, the darker part red. Here the birds are turned in opposite directions, the interlocked idea which we have seen to be so common in fish designs. Figs. 7, 8, and 10 are good examples of this form of design.

Fig. 6 shows birds turned in opposite directions, their mandibles joined into one. In this design the bodies of the birds are represented by a figure bounded on one side by a straight line, the other by a zigzag: a very common form in textiles.

Fig. 7. This design varies but little from the one shown in Fig. 5. If we look at the upper bird's head we find it fairly realistic. From the head, the neck first goes to the left, and then turns at a right angle and descends to the body, which like the bird's body described above consists of a figure bounded by a straight line and a zigzag. In this form of body whether of bird or other animal the number of points, or in other words, the length of the zigzag, is determined by the length of the space to be decorated.

Fig. 8 shows the designs on a piece of vicuña cloth as it is commonly called. The warp threads are of cotton crossed by a weft of vicuña wool which completely covers them. The ground color is a deep reddish-brown, with the decoration in yellow. The effect produced is extremely pleasant and artistic, and has made this textile one of the favorites of art students who have many times copied it in color. It also affords a fine example of the influence of basket work on the art of these people. A greater part of the decoration, the lines bounded by zigzags, is plainly copied from the work of the basket maker. The birds' necks rise and depend from these basket designs.

Fig. 9 shows one bar or unit of a six-unit design. Each of the units is in two colors, but no two alike; yellow birds on red ground, red birds on yellow ground, red birds on black ground, etc. The influence of the technique of basket work is evident enough in these bird figures.

Fig. 10 shows the decoration on a large shawl-like garment. The color of this textile is indigo blue with the designs woven in white in broad stripes. The bird heads are very similar to those in Fig. 9 and the whole design shows unmistakably that it owes its origin to basket technique.

Fig. 11 is a part of a belt or poncho border. The bird decoration is in squares, only two of which are shown. This textile is a curious example of their ingenuity in weaving a number of animal figures into a design, as each square shows four bird heads. The two larger central ones show plainly. These are in black and red. The other two heads are easily found by the eyes at the upper right hand and lower left hand corners, in the light colored (yellow in the original) band that borders the square. If we place a finger on this light-colored band directly over the end of the light projection below the eye, we see a bird head of the same type as those shown in Fig. 8.

Plate IV. Fig. 1 shows a pelican that has just caught a fish. The design is a part of the woven fabric.

Fig. 2 is another large bird that has also been successful in catching a fish. This bird is not woven into the cloth but is in relief. It is made by sewing narrow pieces of braid on the cloth.

Fig. 3 is a bird form not uncommon in tapestry borders to ponchos.

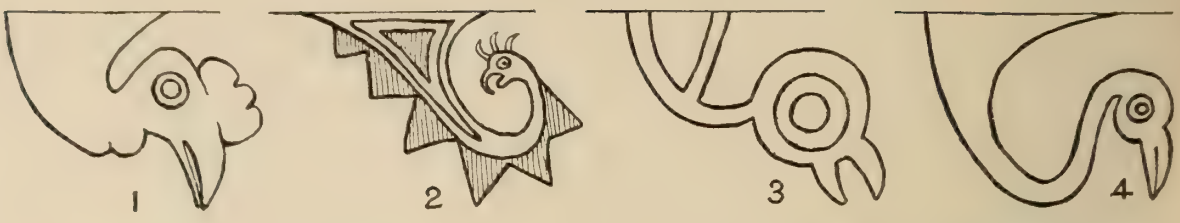
Figs. 4 and 5 are very common bird forms and are found in hundreds of woven fabrics in the collection. Fig. 5 can be taken as the typical conventionalized bird in Peruvian decorative art: a fairly realistic head and neck with the body represented, as we have seen in previous cases, by a design bounded on one side by a straight line and on the other by a zigzag producing chevrons or points.

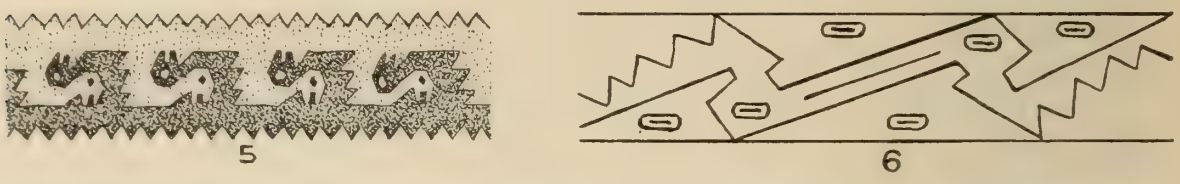
Fig. 6. In this bird figure the same design is used for the tail feathers and the crest on the head. This gives a well-balanced effect to the design, and in a row of such birds there are no large undecorated surfaces to be filled in.

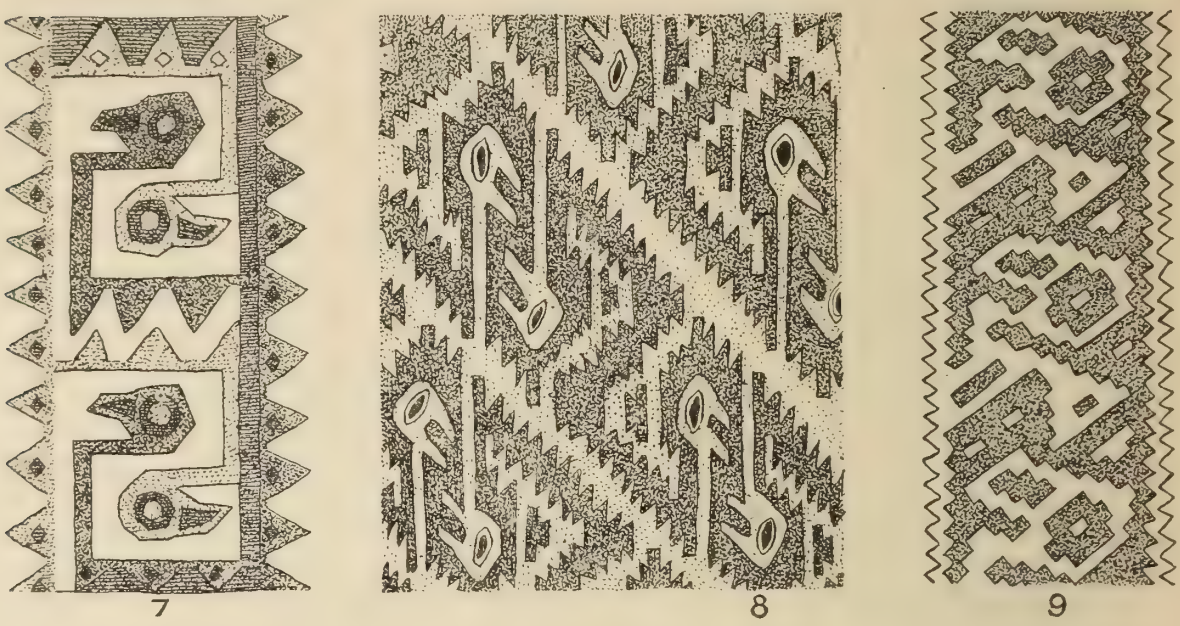
Fig. 7 probably represents a duck and is common both on cloth and pottery.

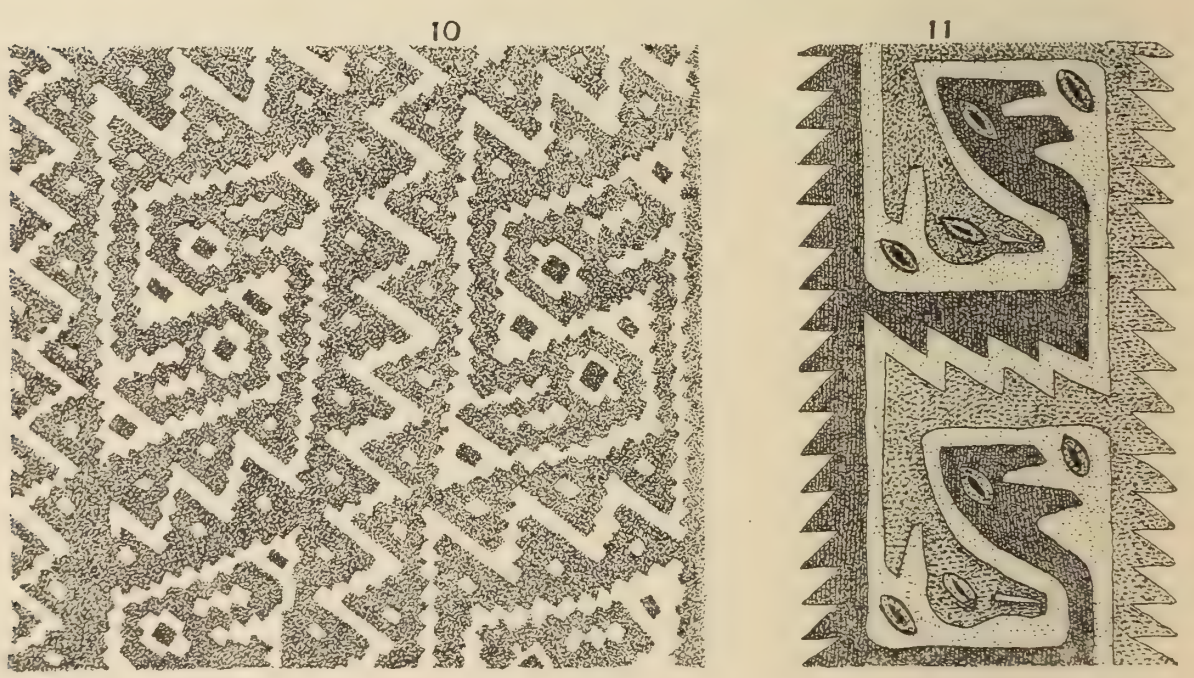
Figs. 8 and 9 are varieties of frets. It would seem that a great resemblance to some of their conventionalized bird forms was noticed and an eye was inserted.

Figs. 10–15 show bird forms which can be found in any considerable collection of Peruvian textiles and require no special comment.



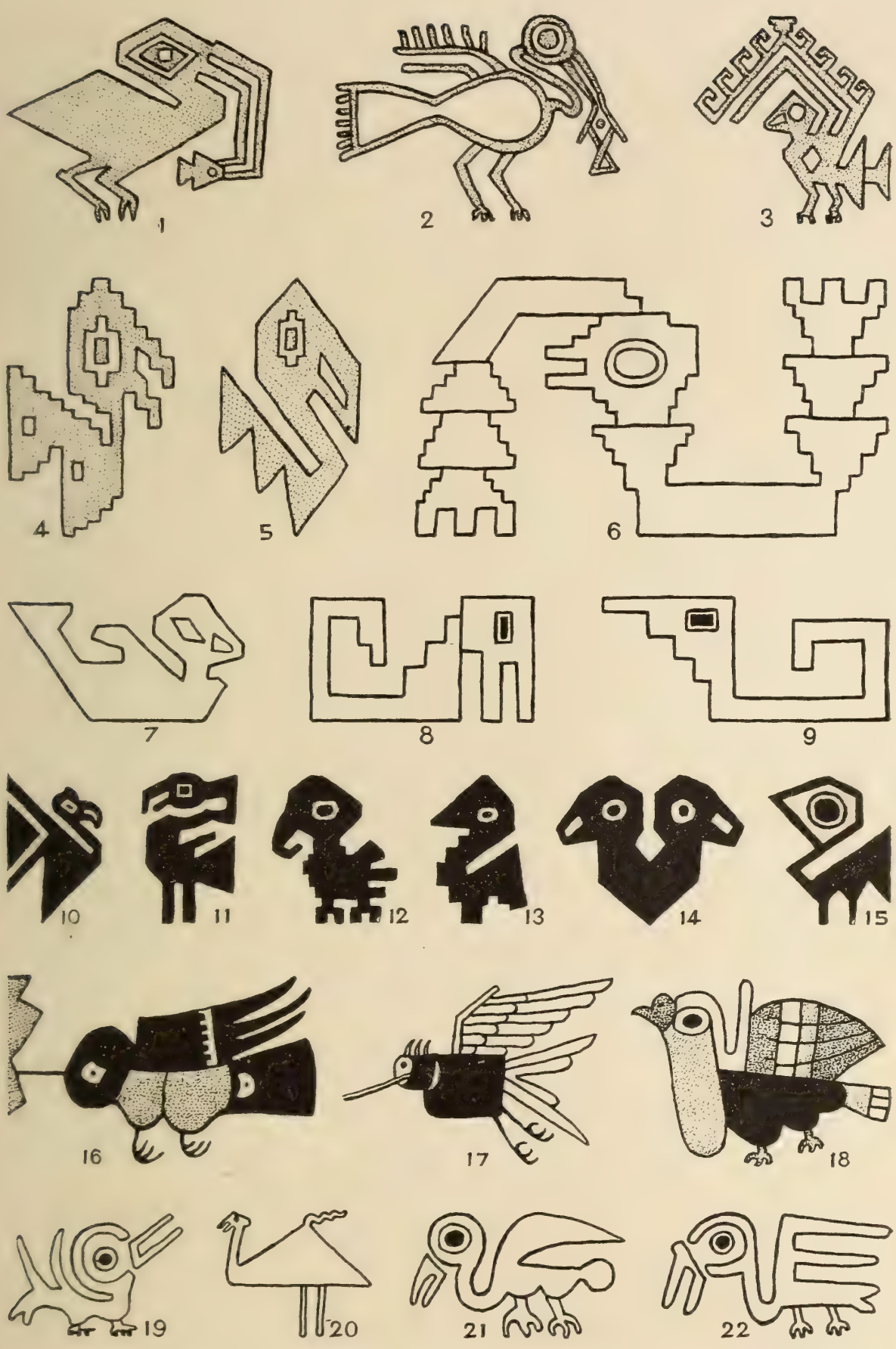




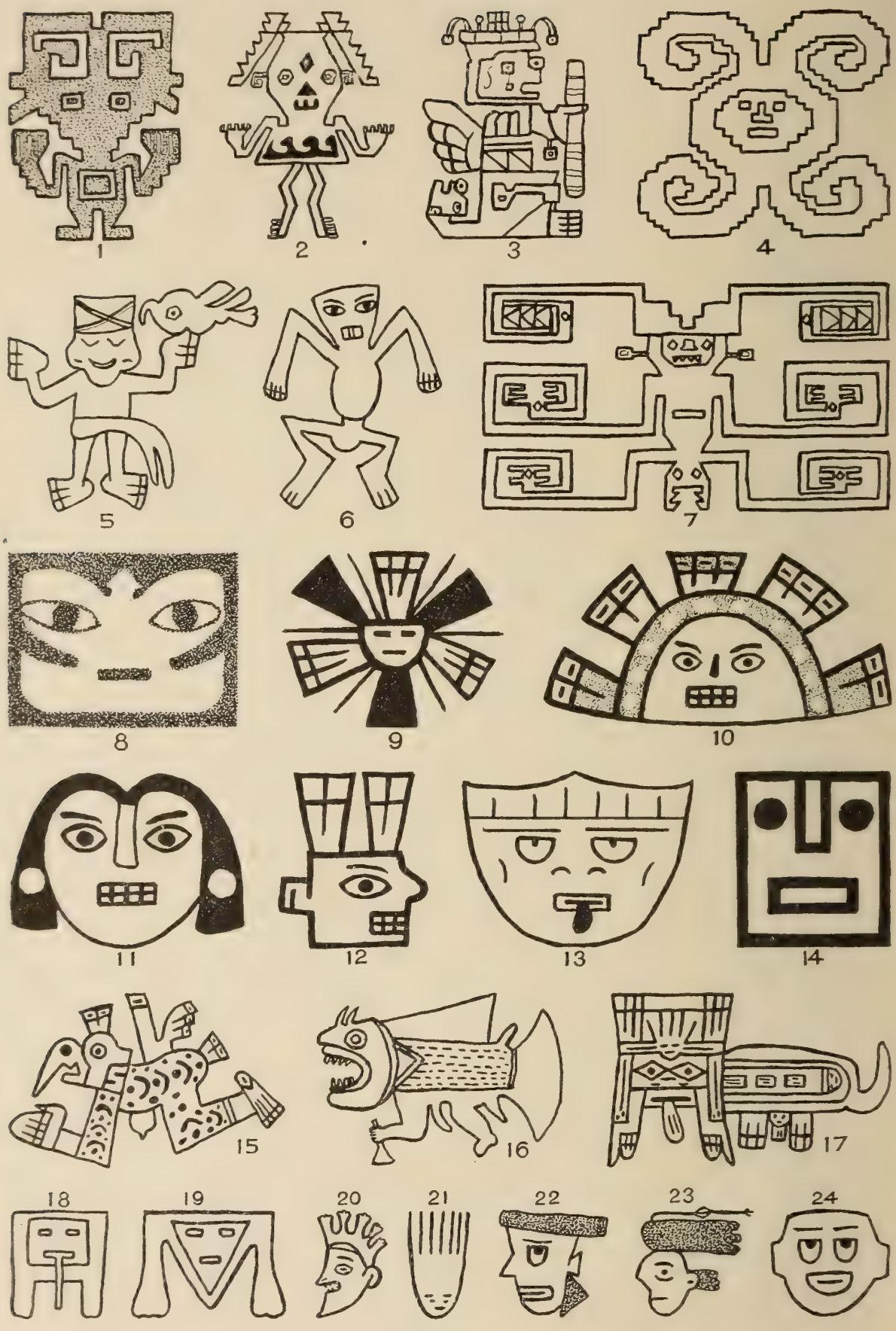


The Bird.

The Cats.



THE BIRD.



Man and Mythological Characters.

Fig. 16 is a humming bird of Nazca pottery. A row of these birds is painted around a pottery vessel. Each bird is sucking honey from a star-shaped flower, which is only partly shown in the illustration.

Fig. 17 is the humming bird on northern coast pottery. This example is painted on a pottery vessel from Trujillo.

Figs. 18–22 show five bird forms painted on Nazca pottery.

THE CATS.

Three members of the cat family, the jaguar, puma, and the *Titi* or mountain cat played an extensive rôle in their decorative art. The puma is found as a decorative motive on pottery and textiles in all parts of the country.

Plate V. Fig. 1 shows a jaguar on a poncho of the Inca period from the Island of Titicaca.

Fig. 2 is a puma from a painted pottery vessel from Chimbote.

Fig. 3 shows the moulded head of the *Titi.* It projects from the side of a pottery vessel. This specimen comes from Caudevilla, near Lima.

Figs. 4–14 are found in the coast region within fifty miles of Lima. Figs. 4 and 5 are common forms in tapestry. In common with other primitive peoples, the Peruvians, when representing an animal form show some prominent characteristic of that animal. In these cat figures we see the raised back common to the cat family.

Fig. 6. The most noticeable thing about this figure is the manner of representing the nose, eyes, and mouth. The technique of weaving seems to have been responsible for this form as Hasluck shows the same device in a lion woven in an old goat-hair carpet from Persia,[1] and certainly no one will claim contact between the prehistoric Peruvians and the Persians. Variations on this device are found in the next four figures.

Fig. 7 shows a highly conventionalized form with the triangular head detached from the body. The characteristics of the cat family, the humped up back and the tail, leave no doubt as to its identity.

Fig. 8 speaks for itself and requires no comment.

Figs. 9 and 10 are forms often met with, especially in textiles from Ancon. In Fig. 9 we see the raised back and tail. Fig. 10 is plainly but a modification of this.

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[1] *Decorative Designs of All Ages for all Purposes*, London, Paris, New York, Toronto, and Melbourne, 1908, p. 128.

Fig. 11 is a design common on cloth, pottery, and in metal objects.

Fig. 12. We have seen, in various fish and bird designs, their fondness for joining two or more animal figures or parts of such figures in the same design. We have illustrations of this in Figs. 12, 13, 15, and 16. In this figure the two cats have a raised back in common.

Fig. 13 shows two conventionalized puma heads joined by a curved band. The design is painted on a beautiful pottery vessel from Pachacamac. These and the balance of the puma heads on this Plate are of the Tiahuanaco style. At first glance the S-shaped band might suggest a serpent, but I have never seen on any Peruvian artifact a serpent head that in any way remotely resembled these. Such puma heads are very common to the Tiahuanaco style as found in Pachacamac. Compare these heads with Figs. 18 and 19 which, as far as I know have always been identified as conventionalized puma heads. If space permitted, a hundred of these heads could easily be shown, each varying in some way from all the others.

Fig. 14. This figure shows a form of facial decoration. It is taken from a vessel from Pachacamac which has for decoration a large human face, painted in colors. One eye and the puma decoration under it is shown in this sketch. In these highly conventionalized puma heads the nose is generally represented by a ring and the mouth by a parallelogram of white enclosed in black or colored lines, with a line through the white surface. This head faces the eye, and the mouth and nose of the puma are against its under side. At the back of the head, that is, at the lower end to the left, is seen a white square enclosed by black lines. Into the white space project two black lines, one from above, and the other from below. This either forms the ear or denotes the opening of the ear. This has been commented on at some length by Dr. Arthur Baessler who styles it "a misdrawn ear." [1] This form of an ear will also be found in painted representations of the human head. See Plate VI, Fig. 12.

Fig. 15. This shows the belt on the central figure on the great monolithic gateway at Tiahuanaco. At either end is seen the typical conventionalized puma head of the Tiahuanaco style. Variations on this form of head are found wherever the influence of Tiahuanaco art was felt. This belt was copied from a plate in the magnificent work of Stübel and Uhle.[2]

Fig. 16. This design is from a pottery vessel from Pachacamac and is painted in colors. If we examine these heads carefully and compare them with others on this plate we find they have the nose of one, the mouth of another, the eye of another, and the same form of ear as in Fig. 15.

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[1] *Ancient Peruvian Art*, Ed. A. H. Kean, description of Plates 136–139. New York, 1902–1903.

[2] *Die Ruinenstaette von Tiahuanaco.*

Fig. 17 shows a puma head from Tiahuanaco. Such heads project from the rims of vessels. Although puma heads, moulded in the round, are common on pottery all over the country, this particular type belongs only to Tiahuanaco. It would appear to be the parent of the legion of conventionalized cat heads in the so-called Tiahuanaco style, a few of which are shown on this Plate.

Figs. 18 and 19 illustrate two common forms on Pachacamac pottery, derived from the puma head. Compare these with that shown in Fig. 14 and it is evident that while they vary in some details they certainly all come from the same animal form.

MAN AND MYTHOLOGICAL CHARACTERS.

On Plate VI are shown designs from the human form and mythological characters which are part man and part animals.

Figs. 1 and 2 are woven designs and require no comment.

Fig. 3 shows a woven design from Pachacamac. It is in the Tiahuanaco style and probably represents the so-called puma god. It is an example of their fondness for combining several animal figures in the same design. Note near the bottom, to the right, the bird's head and neck, and to the left of it a puma's head in the Tiahuanaco style, with its ring nose and peculiar ear.

Fig. 4. In this design the head remains while the other parts of the body have degenerated into scrolls.

Figs. 5 and 6 are from paintings on pottery vessels from Nazca.

Fig. 7. This and similar designs are found in various localities in the coast region. Here the arms, legs, and headdress have degenerated into frets.

Figs. 8 and 9 are from painted designs on Nazca pottery. The face shown in Fig. 8 is peculiar to Nazca and occurs on a great number of their vessels.

Figs. 10 and 11 were taken from paintings on pottery from Pachacamac. Fig. 10 has a headdress of feathers. A common way of representing feathers.

Fig. 12. This head is woven in cloth from Ancon. It shows a headdress of two feathers and the curious "misdrawn ear" of Dr. Baessler which has been noted in several of the designs discussed.

Figs. 13 and 14 show faces from Nazca pottery.

Figs. 15, 16, and 17. That these three figures represent mythological

characters of the pre-Incan people, I think there can be no doubt. They show the man-bird, the man-fish, and the man-cat, and are generally known as the condor god, the fish god, and the puma god. They occur in different parts of the country with such variations as they would naturally undergo through the local art of the people where found. Fig. 15 is from Pachacamac. Fig. 16 is found in various localities on the Coast and is often represented as following two men who are paddling a balsa, and Fig. 17 is from Nazca. All three are from paintings on pottery vessels.

Figs. 18–24 show various designs from the human form and head which were taken from paintings on Nazca pottery.

HIEROGLYPH-LIKE FIGURES.

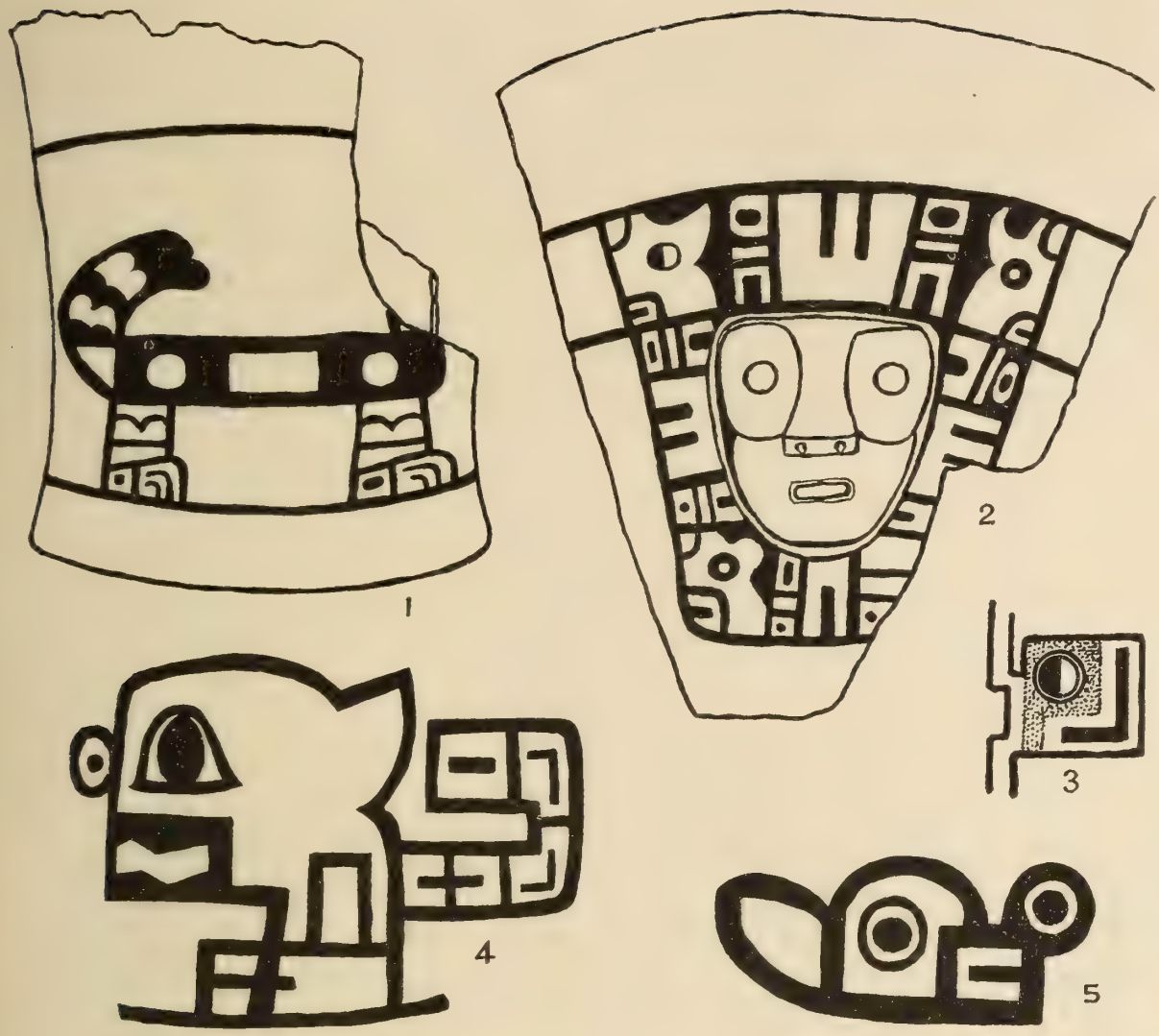
Plate VII deals with the curious glyph-like figures so common on pottery vessels from the Island of Titicaca, Copacabana, and Tiahuanaco. While many of these figures might easily be mistaken for hieroglyphs we shall see that most of them, if not all, are parts of conventionalized animal forms, or the markings on such forms. Several of these designs are usually grouped together on a vessel without, as far as I can see, any relationship one to another; sometimes turned one way and sometimes another.

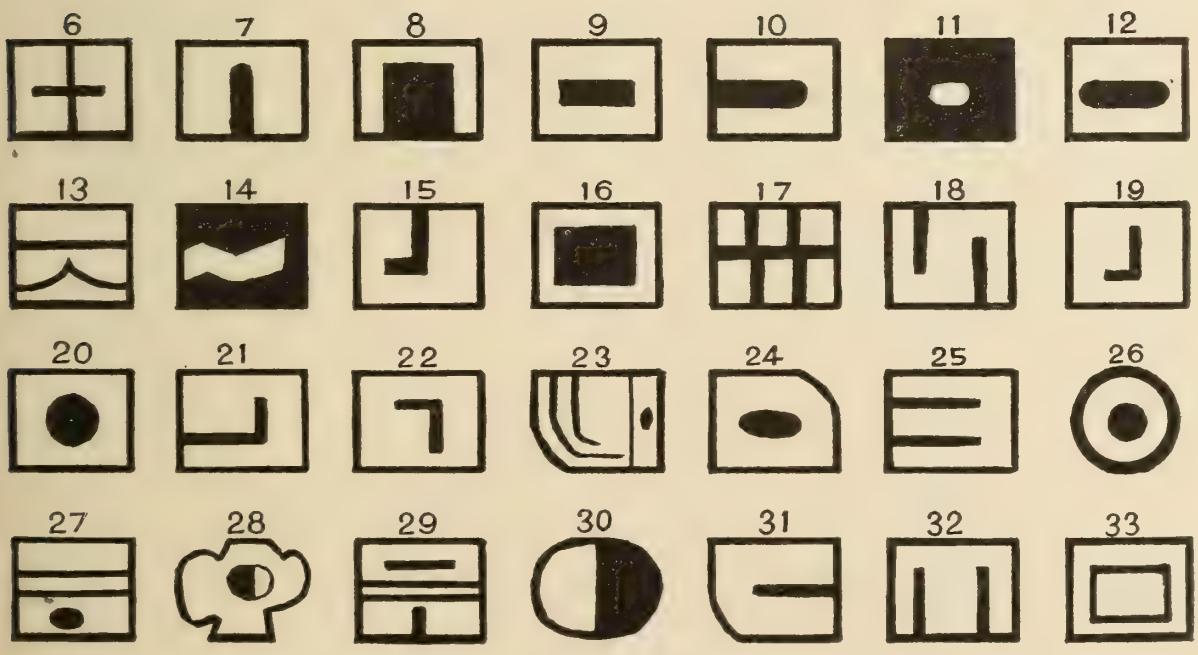
Fig. 1 shows a broken kero or cup of terra cotta from Tiahuanaco. The puma figure has on its legs the same markings as will be found in Fig. 13, and the feet as in Fig. 23. These two figures make clear my meaning when I said above that they were sometimes turned one way and sometimes another.

Fig. 2 represents a large painted potsherd from Tiahuanaco, and it will be seen that quite a number of the glyph-like figures are depicted on it. On the upper curved line of decorations are two llama heads. The one on the extreme left shows a part of the ring nose (Fig. 26), the divided eye (Fig. 30), and the form of mouth shown in Fig. 31. The llama on the right has the ordinary form of eye. Another llama head is seen on the lower line to the left.

Fig. 3 is a puma head on a woven fabric from Pachacamac. The divided eye is like Fig. 30 and this way of representing the mouth will be found in Fig. 19.

Fig. 4 shows a puma figure painted on a clay cup from the Island of Titicaca. Its ring nose is like Fig. 26, its mouth like Fig. 14, and the four designs on the tail will be found in Figs. 6, 12, 19, 22.





Hieroglyph-like Figures.

Fig. 5 is on a painted cup from Copacabana. The mouth is shown in Figs. 7 and 10, the eye and nose in Fig. 26. While studying the various conventionalized animal figures I have noticed that the eye is often represented as in Figs. 11, 16, 20, 26, 30, and 33; the mouth as in Nos. 7, 9, 10, 14, 15, 17, 19, 21, 22, and 31; the ear as in Fig. 18; and the feet as in Fig. 23. Spots on the tips of feathers are shown as in Figs. 9, 11, 12, 16, 20, and 33.

These glyph-like figures were copied from decorations on pottery vessels, but they are also common to the textile fabrics, as we should expect to be the case where freehand drawings were copied in woven designs, and woven figures, with step form lines from the technique of weaving, were in turn copied in decorations on their pottery vessels.

MISCELLANEOUS DESIGNS.

Garcilasso says: —

> Blas Valera a certain Author who in loose Papers wrote of the *Indies*, describes those Nations by distinguishing the former from the latter ages, and faith. That those who live in *Antis* eat Mens Flesh, and are more brutish than the Beasts themselves, for they know neither God, nor Law, nor Virtue, nor have they Idols, or any Worship; unless sometimes when the Devil presents himself to them in the form of a Serpent, or other Animal, they then adore and worship him.[1]

Realistic representations of the serpent or any design originating from it is not characteristic of Peruvian art. However, in the region from Trujillo to Chimbote, pottery vessels have painted figures derived from the serpent, but they have undergone the change so common to serpents in primitive art and have assumed grotesque and monstrous forms. Outside of this region, with the exception of Cuzco, where serpents are sometimes carved on stone vessels, one but seldom finds anything resembling a snake.

Plate VIII. Figs. 1–2 are good examples of forms on Chimbote pottery derived from the serpent.

Figs. 3–10 show various ways in which the llama was represented in paint on pottery. Fig. 6 is one of many llama figures on the inside of a bowl, from ruins on the flank of Illimani Mountain, all the others are from the Island of Titicaca. The last four figures, although highly convention-

[1] *The Royal Commentaries of Peru*, Book 1, Chap. IV.

alized, have the long neck and manner of carrying the ears that stamps them as llamas.

Figs. 11–14. These figures are found among quite a number of illustrations given by Dr. Baessler [1] to show designs derived from the cuttlefish. Fig. 11 certainly represents a cuttlefish, and while I believe the other designs are derived from the tentacles of that animal I prefer to leave the responsibility of the identification on the Doctor's shoulders. The designs given are common on pottery vessels from Chimbote and Trujillo.

Figs. 15–18 and 28 show examples of decorative forms taken from plant life. Among the old Peruvian designs we occasionally find plant forms woven in cloth and painted on pottery vessels. Figs. 15–16 appear to represent plants of the compositæ family with roots, stem, leaves, and heads of blossoms. Both were taken from pieces of tapestry found at Pachacamac.

Fig. 17 shows water rushes (probably cypenes) painted on a jar from Chimbote. The original design has two bunches of these rushes and fish are shown swimming between them.

Fig. 18 is a highly conventionalized flower. Humming birds are sometimes represented in the act of extracting honey from such flowers. In the art of Nazca the humming bird is shown drawing honey from a flower represented by a six-pointed star. This has been figured on Plate IV, Fig. 16.

Figs. 19–23. The Peruvian artists' fondness for combining two or more animal forms in a design is shown in these figures. Figs. 19 and 20 are woven in cloth from Ancon. The first shows the cat and bird, the second the fish and bird.

Figs. 21–23 show designs burned into the sides of gourd vessels. The first shows the cat and two birds; the second the cat and two fish; and the third the cat, bird, and fish. The identity of the cat heads and of the birds in these three designs has always been recognized by art students using the Museum's collections; but in my experience few of them see the fish motive in this highly conventionalized form until their attention is called to other designs where practically the same form of fish is shown, but under conditions that make its true nature more apparent. See the lower or shaded fish form of the interlocked fish design in Fig. 6, Plate II.

Figs. 24–27 are examples of a rather common form in designs, where four of the same animals or parts of such animals are combined in a design. In Fig. 24 we have four bird heads. In Fig. 25 lizards are represented. Fig. 26 shows four cat heads of a familiar type, and Fig. 27 heads of the puma. This design is from the work of T. A. Joyce,[2] and is engraved on

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[1] *Ancient Peruvian Art*, vol 1, Plates 1–5.

[2] *South American Archaeology*, New York, 1912.

MISCELLANEOUS DESIGNS.

a portion of a stone cup from Tiahuanaco, in the collection of the British Museum. These heads have always been identified as puma heads, and are similar to those on the great gateway of Ak-kapana at Tiahuanaco. Various forms of this head will be found on Plate V, Figs. 13–19.

Fig. 28. This represents a cactus plant, and is from a painting on a jar from Chimbote.

In the northern coast region figures apparently representing various species of cacti are not uncommon on painted pottery vessels. As a rule, primitive peoples derive their decorative motives largely from such animals as they are acquainted with, and but rarely invade the plant world in search of designs. In what would seem to be the natural progression in the development of ornamentation, the frequent use of plants, or their derivatives, would indicate a considerable antiquity for the art of a people. While we find animal motives largely predominating in Peru, a very considerable number of plant forms are present.

REMARKS.

While it does not properly come within the scope of this paper, it may be well, in conclusion, to say a few words concerning the realistic side of Peruvian art, which went on side by side with the higher or conventionalized side. They were fond of representing objects and scenes familiar to them in their daily life and in the forms of their pottery vessels and decorations on them they have left us models of their houses, shelters used by shepherds in the fields, portrait vases, fishing and hunting scenes, groups showing ceremonies and dances, clothing and manner of wearing it, personal ornaments, their musical instruments, most if not all the animals known to them, and a great variety of fish and birds.

Of the fruits and vegetables eaten by the ancient Peruvians we have an almost complete record. Indian corn or maize was a favorite subject with these potters. Sometimes a mould was made from an ear of corn, a cast of clay made in it and this cast attached to the vessel before firing. Many of the so-called "corn-gods" were so decorated. Corn was carved and painted on pottery, carved in stone, and occasionally represented in textile fabrics. Moulds were also made from peanuts, and many vessels from Chimbote have their upper surfaces completely covered with perfect representations of this vegetable. Other vegetable forms in the Museum's collections, that can be positively identified are squashes, manioc, chirimoya, granadilla, palta, lucma, paccay, beans, chili peppers, and coca leaves which they chewed with lime.

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